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OF THE UNITED STATES

# FEDERAL REGISTER

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*Washington, Friday, September 24, 1937*

## PRESIDENT OF THE UNITED STATES.

### EXECUTIVE ORDER

DESIGNATING JOHN D. BIGGERS ADMINISTRATOR OF AN  
UNEMPLOYMENT CENSUS

By virtue of and pursuant to the authority vested in me by the act of August 30, 1937 (Public No. 409, 75th Congress), providing for a census of partial employment, unemployment, and occupations, I hereby designate as Administrator thereof John D. Biggers and delegate to him the following functions and duties:

1. The Administrator, as the administering agency, is authorized and directed to conduct the said census and upon completion thereof to issue a report of findings.

2. The Administrator is authorized to appoint, as temporary employees, and fix the compensation, without regard to the Classification Act of 1923, as amended, of such officers, agents, and other personnel, and to make such other expenditures, as may be necessary to carry out the provisions of said act of August 30, 1937, including purchase of materials, supplies, and office equipment, newspapers, periodicals and press clippings, printing and binding, communication services, travel, rent at the seat of Government and elsewhere, contract stenographic reporting services, special messenger service, mimeographing and other duplicating services, rental or purchase of machines and labor saving devices.

To meet the expenses of conducting the said census, allocations will be made, pursuant to the provisions of section 3 of the said act of August 30, 1937, in a total amount not exceeding \$5,000,000 from the appropriation contained in the Emergency Relief Appropriation Act of 1937.

FRANKLIN D ROOSEVELT

THE WHITE HOUSE,  
September 22, 1937.

[No. 7711]

[F. R. Doc. 37-2823; Filed, September 23, 1937; 12:30 p. m.]

## DEPARTMENT OF COMMERCE.

### Bureau of Air Commerce.

#### CIVIL AIR REGULATIONS

Pursuant to the authority contained in the Air Commerce Act of 1926 (44 Stat. 568) as amended, and as further amended by the Act of June 19, 1934 (48 Stat. 1113), and the Act of June 19, 1934 (48 Stat. 1116), the following civil air regulations are hereby made, established, and issued to be known as

- Chapter 00. Aircraft Registration Certificate
- Chapter 01. Aircraft Certificates
- Chapter 02. Aircraft Identification Mark
- Chapter 03. Aircraft Title Transfer
- Chapter 04. Airplane Airworthiness

- Chapter 13. Aircraft Engine Airworthiness
- Chapter 14. Aircraft Propeller Airworthiness
- Chapter 15. Aircraft Equipment Airworthiness
- Chapter 18. Repair and Alteration of Aircraft

Any and all rules or regulations made, established, and issued by the Secretary of Commerce under the authority of such act, as amended, as are inconsistent with the provisions of the above specified civil air regulations are hereby repealed.

Approved, to take effect November 1, 1937, unless otherwise specifically provided in a particular chapter or part thereof.

[SEAL]

DANIEL C. ROPER,  
Secretary of Commerce.

#### 00. AIRCRAFT REGISTRATION CERTIFICATE

- 00.0 Provision for Issuance
- 00.1 Eligibility
- 00.2 Application
- 00.20 Documentary Evidence of Ownership
- 00.3 Issuance
- 00.30 Temporary Certificate
- 00.4 Display
- 00.5 As Evidence
- 00.6 Duration
- 00.7 Non-Transferability
- 00.8 Suspension or Revocation
- 00.9 Surrender

#### CHAPTER 00. AIRCRAFT REGISTRATION CERTIFICATE

00.0. *Provision for issuance.*—Pursuant to the provisions of the Air Commerce Act requiring the Secretary of Commerce to provide for the granting of registration to aircraft eligible therefor, a registration certificate will be issued by the Secretary for purposes of identifying the aircraft and determining its nationality, upon request of the owner and approval of application made and proofs submitted, for any aircraft duly shown to be eligible for such registration as an aircraft of the United States. A record of such registration will be maintained by the Secretary.

00.01. Except for changes in eligibility and/or ownership, the validity of the present registration of each aircraft shall be concurrent with the validity of its license for airworthiness in force on the date these regulations go into effect.

00.1. *Eligibility.*—No aircraft shall be eligible for registration unless

(a) it is a civil aircraft owned by a citizen of the United States and is not registered under the laws of any foreign country, or unless

(b) it is a public aircraft of a Federal Government or of a State, Territory or possession, or of a political subdivision thereof.

00.2. *Application.*—The owner of any aircraft, who desires a registration certificate for the aircraft as an aircraft of the United States, shall make application therefor to the Secretary upon a form supplied for the purpose, which may



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OF THE UNITED STATES  
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be combined with the application for a certificate of airworthiness under CAR 01.

00.20. *Documentary evidence of ownership.*—The following documents may be considered as acceptable evidence of ownership for the registration of aircraft.

00.200. New aircraft, owned by the manufacturer, and for which the manufacturer applies for registration: The appropriate application form.

00.201. *Registered aircraft.*—The registration certificate, issued for such aircraft, executed in accordance with the provisions of CAR 03. If such registration certificate has been lost or destroyed, an affidavit to that effect must be submitted, together with an application for registration on the appropriate form, accompanied by

(a) A certified copy of a bill of sale which transfers all right, title and interest in and to the aircraft to the purchaser, or

(b) A duly authenticated bill of sale from a public officer duly authorized to issue same, with the authority of said officer certified thereon.

(c) A certified copy of an order of court of competent jurisdiction determining title.

00.3. *Issuance.*—Upon approval of an application duly made and proofs submitted, a registration certificate will be issued by the Secretary, together with an identification mark as provided in CAR 02.20.

00.30. *Temporary certificate.*—Pending the issuance of a certificate, a Bureau inspector may issue a temporary registration certificate, together with an identification mark as provided in CAR 02.21.

00.4. *Display.*—The registration certificate shall be carried in the aircraft at all times, and shall be presented for inspection upon the demand of any authorized official or employee of the Department of Commerce, or upon the reasonable request of any other person.

00.5. *As evidence.*—For the purpose of exercising any privilege granted by any international convention, or of enforcing national laws, the registration certificate (or registration) will be deemed prima facie evidence of the nationality of the aircraft.

00.6. *Duration.*—A registration certificate, when issued, will remain effective for an indeterminate time, or until

(a) the aircraft is no longer eligible for registration as an aircraft of the United States, or

(b) ownership of the aircraft is transferred, or

(c) registration of the aircraft is cancelled at the written request of the owner, or

(d) registration of the aircraft is suspended or revoked.

00.7. *Non-transferability.*—A registration certificate is not transferable. (For effect of transfer of title on the registration certificate, see CAR 03.)

00.8. *Suspension or revocation.*—A registration certificate may be suspended or revoked for any of the following reasons:

(a) Any false statement by the owner in his application for said certificate, or in any information accompanying the application.

(b) Loss of eligibility as defined in CAR 00.1.

(c) Any other reason causing the aircraft to become ineligible for registration as an aircraft of the United States.

00.9. *Surrender.*—Upon notice from the Secretary of the suspension or revocation of a registration certificate, the owner of the aircraft to whom same has been issued shall promptly return such certificate to the Secretary.

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## CHAPTER 01. AIRCRAFT CERTIFICATES

## 01.0. General.—

01.00. *Provision for issuance.*—Pursuant to the provisions of the Air Commerce Act requiring the Secretary of Commerce to provide for the rating of aircraft as to their airworthiness, the Secretary will issue aircraft certificates as defined in CAR 01.12 through 01.15 and in accordance with the following provisions.

## 01.1. Definitions.—

01.10. *Certificated aircraft.*—The Air Commerce Act and the Civil Air Regulations provide that an aircraft rated as to airworthiness must first be registered as an aircraft of the United States. Therefore, as used throughout the Civil Air Regulations, the term "certificated aircraft" means any aircraft for which an aircraft certificate other than a registration certificate has been issued.

01.11. *Airworthy.*—As used herein the term "airworthy" when applied to a particular aircraft or component thereof denotes the ability of such aircraft or component thereof to perform its function satisfactorily throughout a range of operations determined by the Secretary in rating the aircraft or component thereof.

01.12. *Experimental.*—As used herein, the term "experimental" when applied to an aircraft denotes that such aircraft is certificated for experimentation in flight with a view to determining or improving its characteristics or those of its components or equipment, and that inspection has disclosed no unairworthy feature of such aircraft with respect to structural integrity, workmanship or flight characteristics.

01.13. *Airworthiness certificate.*—An airworthiness certificate is hereby defined as a document issued by the Secretary to the registered owner of an aircraft, certifying that the aircraft in question is airworthy when operated and maintained in accordance with the terms of said certificate.

01.14. *Experimental certificate.*—An experimental certificate is hereby defined as a document which may be issued by the Secretary to the registered owner of an aircraft, certifying that the aircraft in question is an experimental aircraft and specifying such operation limitations as are deemed necessary by the Secretary.

01.15. *Type certificate.*—A type certificate is hereby defined as a document issued by the Secretary to a manufacturer or designer of aircraft or certain components thereof (See CAR 13, 14 and 15), certifying that the type of aircraft or component, as represented by authenticated data in the form of specifications, descriptions and drawings on file in the Office of the Secretary, has been found to be suitable as a basis for the manufacture of airworthy aircraft or components constructed in accordance with such data.

01.16. *Production certificate.*—A production certificate is hereby defined as a document issued by the Secretary to a manufacturer of aircraft or certain components thereof (See CAR 13, 14 and 15), for which a type certificate has been

granted, certifying that said manufacturer has complied with the requirements of CAR 01.5 for the production of aircraft or components thereof in quantities of an exact similarity of type, structure, materials, assembly and workmanship with the specifications, descriptions and drawings forming the basis for said type certificate.

01.17. *Aircraft.*—The term "aircraft" as defined in the Air Commerce Act means any contrivance now known or hereinafter invented, used or designed for navigation of or flight in the air, except a parachute or other contrivance designed for such navigation but used primarily as safety equipment. For the purpose of these regulations aircraft are further classified in the following paragraphs.

01.170. *Airplane.*—A mechanically driven fixed-wing aircraft, heavier than air, which is supported by the dynamic reaction of the air against its wings.

01.171. *Glider.*—An aircraft heavier than air, similar to an airplane but without a powerplant.

01.172. *Rotorplane.*—A form of aircraft whose support in the air is chiefly derived from the vertical component of the force produced by rotating airfoils.

01.173. *Aerostat (lighter-than-air aircraft).*—An aircraft whose support is chiefly due to buoyancy derived from aerostatic forces. Aerostats are further classified as balloons and airships.

## 01.2. Airworthiness certificates.

01.20. *Eligibility for airworthiness certificate.*—Application for an airworthiness certificate may be made by the owner of any aircraft eligible for registration as an aircraft of the United States including, in addition to those aircraft for which such certificate is required as provided in CAR 60, the following:

(a) Aircraft used solely for pleasure or non-commercial purposes.

(b) Aircraft belonging to the United States.

(c) Aircraft belonging to any State, Territory or possession of the United States or to a political subdivision thereof, and used exclusively in the governmental service.

01.21. *Application for airworthiness certificates.*—Application for an airworthiness certificate shall be made to the Secretary on a form supplied for the purpose.

01.22. *Kinds of airworthiness certificates.*—Airworthiness certificates are classified by the symbols C and R, for the meaning of which see CAR 02. Airworthiness certificates are further classified and modified by means of operation limitations which will appear on the certificate.

01.220. *Classification of airworthiness certificates for airplanes.*—Airworthiness certificates for airplanes are classified as to one or more operations as follows:

(a) Non-airline carrier use.

(b) Airline carrier use (Goods).

(c) Airline carrier use (Passengers).

(d) Visual-contact flying.

(e) Instrument flying.

(f) Day flying.

(g) Night flying.

(h) No passengers to be carried at any time.

(i) Flights to be confined to 100 miles from fixed base.

(j) Special industrial operations.

01.221. *Classification of airworthiness certificates for gliders.*—Airworthiness certificates for gliders are classified as to operation as follows:

(a) Acrobatic flying.

(b) Airplane towing.

(c) Auto towing.

(d) Shock launching.

(e) Commercial use.

(f) Non-commercial use.

(g) Day flying.

(h) Night flying.

(i) No passengers to be carried at any time.

01.222. *Classification of airworthiness certificates for rotorplanes.*—Airworthiness certificates for rotorplanes are



classified as to operation as outlined in CAR 01.220 for airplanes.

01.223. *Classification of airworthiness certificates for aerostats.*—Airworthiness certificates for aerostats are classified as to operation as outlined in CAR 01.220 for airplanes.

01.23. *Requirements for issuance of airworthiness certificates.*

01.230. *Airworthiness requirements.*—For certain classes of aircraft and for definite types of operation the requirements for airworthiness hereinafter specified shall be complied with. They are set forth in the following:

Airplanes, CAR 04  
Gliders, CAR 05  
Rotorplanes, CAR 06  
Aerostats, CAR 07

01.2300. A new aircraft manufactured subsequent to the effective date of these regulations and in accordance with an approval previously issued will be eligible for airworthiness certification after inspection showing compliance with the terms of the current Aircraft Specification previously issued therefor.

01.2301. Aircraft holding a valid commercial license will be eligible for airworthiness certification on expiration of such license and after inspection showing continued airworthiness and compliance with the terms of the current Aircraft Specification previously issued therefor.

01.231. *Inspection of aircraft.*—Each individual aircraft for which an airworthiness certificate is desired shall be presented for inspection to a designated representative of the Secretary for the purpose of determining the airworthiness of the aircraft.

01.2310. The registered owner of any aircraft shall offer full cooperation with respect to any inspection which may be made of said aircraft upon proper demand by any authorized representative of the Secretary prior or subsequent to the issuance of an airworthiness certificate.

01.232. *Display of Identification Data.*—To facilitate inspection of the aircraft and for purposes of identifying the aircraft with the documents accepted as the basis of the airworthiness certificate, certain manufacturer's and other data shall be displayed as follows, so far as applicable to the type of aircraft involved:

01.2320 (a). An aircraft identification mark in accordance with the provisions of CAR 02.

01.2321 (b). The identification plate and other identifying information required under the pertinent airworthiness requirements of CAR 04, 05, 06 or 07, as the case may be.

01.24. *Issuance.*—Upon application duly made and proofs submitted, an airworthiness certificate will be issued in an appropriate form.

01.25. *Display.*—An airworthiness certificate which has been issued for an aircraft shall be carried therein at all times and shall be posted therein where it may be readily seen by passengers, and any such certificate shall be presented for inspection upon the demand of any passenger, any authorized representative of the Bureau and any State or municipal official charged with enforcing local laws or regulations involving Federal compliance, or upon the reasonable request of any other person.

01.26. *Duration, renewal and non-transferability.*—

01.260. *Duration.*—An airworthiness certificate will remain in force for a period of one year from date of issuance unless specifically limited to a shorter period, or until sooner suspended, revoked or canceled in accordance with the provisions of CAR 01.26.

01.261. *Renewal.*—The term of an airworthiness certificate may be renewed for additional periods of one year, or for shorter periods, on application of the registered owner to the Secretary or to a designated Bureau inspector, provided proof is made satisfactorily to show

- (a) that the aircraft is still airworthy, and
- (b) that the ownership is still as registered.

01.262. *Non-transferability.*—An airworthiness certificate is not transferable. However, such certificate may be re-issued to an owner other than the original holder thereof provided such other owner meets all the requirements pertaining thereto and makes proper application and proofs therefor in accordance with the provisions of CAR 03.

01.27. *Suspension, revocation, cancellation and surrender.*—

01.270. *Suspension or revocation.*—An airworthiness certificate may be suspended or revoked by reason of any of the following on the part of the holder thereof:

01.2700 (a). The making of any false statement in an application for such certificate, or in any information accompanying such application, or in any report required by the Secretary.

01.2701 (b). Failure to make any report required by the Secretary.

01.2702 (c). Using or displaying such airworthiness certificate for a fraudulent purpose or using or displaying any airworthiness certificate or identification mark in any manner contrary to the public safety or interest.

01.2703 (d). Moral irresponsibility.

01.2704 (e). Violation, or permitting violation, of any provision of the Air Commerce Act or any rule or regulation duly issued thereunder.

01.2705 (f). Operating, or permitting the operation of, the aircraft in violation of any of the terms of its airworthiness certificate.

01.2706 (g). Failure to maintain the aircraft in an airworthy condition in accordance with CAR 01.72.

01.271. *Automatic suspension.*—

01.2710 (a). When an aircraft possessed of a valid airworthiness certificate is removed from the continental limits of the United States for the purpose of air navigation wholly within a foreign country, such certificate automatically becomes invalid, and may be suspended or revoked unless prior approval has been received from the Secretary.

01.2711 (b). When an aircraft possessed of a valid airworthiness certificate has been damaged, such certificate automatically becomes invalid until the aircraft has been repaired, inspected and re-rated in accordance with the provisions of CAR 18.

01.272. *Cancellation.*—An airworthiness certificate issued to the registered owner of an aircraft will be canceled upon the written request of such owner.

01.273. *Surrender.*—Upon notice from the Secretary of the suspension or revocation of an airworthiness certificate, or in case of cancellation thereof, the registered owner of the aircraft to whom it has been issued shall immediately return such certificate to the Secretary.

01.3. *Experimental certificates.*—

01.30. *Eligibility for experimental certificate.*—Application for an experimental certificate may be made by the registered owner of the following aircraft:

(a) Aircraft used solely for experimental purposes as defined in CAR 01.12 herein.

(b) Aircraft belonging to the United States.

(c) Aircraft belonging to any State, Territory or possession of the United States or to a political subdivision thereof, and used exclusively in the governmental service.

01.31. *Application for experimental certificate.*—Application for an experimental certificate shall be made to the Secretary upon a form supplied for the purpose.

01.32. *Kinds of experimental certificates.*—Experimental certificates are classified by the symbol X, for the meaning of which see CAR 02. Experimental certificates are further classified and modified by means of operation limitations which will appear on the certificate.

01.33. *Requirements for issuance of experimental certificates.*—

01.330. *Minimum requirements.*—Applicant shall show that the aircraft is to be used for experimental purposes as defined



in CAR 01.12 and the aircraft shall satisfactorily undergo the inspection required by CAR 01.331.

01.331. *Inspection of aircraft.*—An aircraft for which an experimental certificate is desired shall be presented for inspection to a designated representative of the Secretary for the purpose of determining that it is an experimental aircraft as defined in CAR 01.12 and that no unairworthy feature with respect to structural integrity, workmanship or flight characteristics is evident. After inspection, such representative will establish suitable operation limitations for incorporation in the certificate when issued.

01.3310. The registered owner of any aircraft shall offer full cooperation with respect to any inspection which may be made of said aircraft upon proper demand by any authorized representative of the Secretary prior or subsequent to the issuance of an experimental certificate.

01.332. *Display of identification data.*—To facilitate inspection and for purposes of identifying the aircraft as an experimental aircraft, certain data shall be displayed as follows:

01.3320 (a). An aircraft identification mark in accordance with the provisions of CAR 02.

01.3321 (b). A metal plate permanently affixed in a visible location in the pilot's cockpit or compartment bearing the date of manufacture and the name of manufacturer, the manufacturer's serial number and the model designation.

01.34. *Issuance.*—Upon approval of application duly made and proofs submitted, an experimental certificate will be issued in appropriate form.

01.35. *Display.*—An experimental certificate which has been issued for an aircraft shall be carried therein at all times and shall be posted therein where it may be readily seen, and any such certificate shall be presented for inspection upon the demand of any authorized representative of the Bureau and any State or municipal official charged with enforcing local laws or regulations involving Federal compliance, or upon the reasonable request of any other person.

01.36. *Duration, renewal and non-transferability.*—

01.360. *Duration.*—An experimental certification will remain in force for such a period from date of issuance as specifically stated thereon, or until sooner suspended, revoked or canceled in accordance with the provisions of CAR 01.36.

01.361. *Renewal.*—The term of an experimental certificate may be renewed for additional periods on application of the registered owner to the Secretary or to a designated Bureau inspector, provided proof is made satisfactorily to show:

- (a) that the aircraft is still being used for experimental purposes as set forth in CAR 01.330, and
- (b) that the ownership is still as registered.

01.362. *Non-transferability.*—An experimental certificate is not transferable. However, such certificate may be re-issued to an owner other than the original holder thereof provided such other owner meets all the requirements pertaining thereto and makes proper application and proofs therefor in accordance with the provisions of CAR 03.

01.37. *Suspension, revocation, cancellation and surrender.*—

01.370. *Suspension or revocation.*—An experimental certificate may be suspended or revoked by reason of any of the following on the part of the holder thereof:

01.3700 (a). The making of any false statement in an application for such certificate, or in any information accompanying the application, or in any report required by the Secretary.

01.3701 (b). Using or displaying such experimental certificate for a fraudulent purpose, or using or displaying any experimental certificate or identification mark in any manner contrary to the public safety or interest.

01.3702 (c). Moral irresponsibility.

01.3703 (d). Violation, or permitting violation, of any provision of the Air Commerce Act or any rule or regulation duly issued thereunder.

01.3704 (e). Operating, or permitting the operation of, the aircraft in violation of any of the terms of its experimental certificate.

01.371. *Cancellation.*—An experimental certificate issued to the registered owner of an aircraft will be canceled upon the written request of such owner.

01.372. *Surrender.*—Upon notice from the Secretary of the suspension or revocation of an experimental certificate, or in case of cancellation thereof, the registered owner of the aircraft for which it has been issued shall immediately return such certificate to the Secretary.

01.4. *Type certificates.*—

01.40. *Application for type certificate.*—Application for a type certificate for any aircraft, engine, propeller, or other aeronautical equipment as provided for in CAR 15, shall be made to the Secretary upon a form supplied for the purpose.

01.41. *Kinds of type certificates.*—Type certificates are classified as to type of aircraft or component for which issued.

01.42. *Requirements for issuance of type certificates.*—

01.420. *Airworthiness of type.*—As one requisite to the issuance of a type certificate, the airworthiness of the type of aircraft or component shall be established to the satisfaction of the Secretary. This will require the construction of at least one complete aircraft or component of the type for which the type certificate is desired. In the case of aircraft it is further required that an airworthiness certificate (see CAR 01.2) be obtained for an aircraft of the type in question. For certain classes of aircraft and components the requirements for airworthiness, including special requirements for type certification, are specified hereinafter as follows:

- Airplanes, CAR 04.
- Gliders, CAR 05.
- Rotorplanes, CAR 06.
- Aerostats, CAR 07.
- Aircraft Engines, CAR 13.
- Aircraft Propellers, CAR 14.
- Aircraft Equipment, CAR 15.

01.421. *Technical data required.*—The applicant for a type certificate shall submit, together with the application or following such application, technical data representing the type of aircraft or component for which a type certificate is desired. Such data shall comply with the requirements specifically provided for this purpose. (See CAR 01.420 for reference thereto.)

01.422. *Inspection.*—The applicant for a type certificate shall offer full cooperation with respect to any inspection which may be made upon proper demand by any authorized representative of the Secretary prior or subsequent to the issuance of such type certificate.

01.43. *Issuance.*—Upon approval of an application duly made and proofs submitted, a type certificate will be issued in an appropriate form.

01.44. *Certification under type certificate.*—An aircraft or component manufactured under a type certificate and in accordance with the terms thereof may be certificated as airworthy on the basis of the airworthiness rating of the original article of the type for which said type certificate was issued, upon proof that the article in question conforms exactly with the authenticated data forming a part of said type certificate; provided, however, that each article shall satisfactorily pass such inspections as to workmanship, installation, assembly and flight characteristics as the Secretary may deem necessary.

01.45. *Display.*—Any type certificate, including such papers and data as may be a part thereof, shall be presented for inspection upon the demand of any authorized representative of the Bureau and of any State or municipal official charged with enforcing local laws or regulations involving Federal compliance.

01.46. *Duration, transfer and license.*—



01.460. *Duration.*—A type certificate will be issued for an indeterminate period of time and shall remain effective until it is suspended or revoked, or is canceled upon the written request of the holder thereof.

01.461. *Transfer and license.*—A type certificate is transferable and the benefits of such certificate may be extended by licensing arrangements.

01.47. *Suspension, revocation, cancellation and surrender.*—

01.470. *Suspension or revocation.*—A type certificate may be suspended or revoked in the event of unsatisfactory or unsafe performance in service of aircraft, engines, propellers or other aeronautical equipment for which such type certificate has been issued, and by reason of any of the following on the part of the holder thereof:

01.4700. (a) The making of any false statement in an application for said certificate, or in any information accompanying the application, or in any report required by the Secretary.

01.4701. (b) Failure to make any report required by the Secretary.

01.4702. (c) Use or display of any type certificate or other official notification from the Bureau for a fraudulent purpose; or misrepresentation of any certificated product; or use or display of any type certificate or other official notification from the Bureau in any manner contrary to the public safety or interest.

01.4703. (d) Alteration of the basic design or specifications of an aircraft, engine, propeller or other aeronautical equipment for which a type certificate has been issued, without first having such alteration approved by the Secretary.

01.4704. (e) Refusal to submit to inspection upon proper demand by an authorized representative of the Secretary or to render any reasonable assistance in connection therewith.

01.4705. (f) Moral irresponsibility.

01.4706. (g) Violation of the Air Commerce Act or any rule or regulation duly issued thereunder.

01.471. *Cancellation.*—A type certificate will be canceled on the request of the holder thereof.

01.472. *Surrender.*—Upon notice from the Secretary of the suspension or revocation of a type certificate, or in case of cancellation thereof, the holder thereof shall immediately return such certificate to the Secretary.

01.48. *Confidential nature of data.*—Technical data furnished by manufacturers or designers of aircraft, engines, propellers or other aeronautical equipment, in compliance with the procedure established for the issuance of a type certificate therefor, will be treated as confidential by all employees of the Department of Commerce for such time as the certificate is in force.

01.5. *Production certificates.*—

01.50. *Application for production certificate.*—Application for a production certificate for any aircraft, engine, propeller, or other aeronautical equipment shall be made to the Secretary upon a form supplied for the purpose.

01.51. *Kinds of production certificates.*—Production certificates are classified as to type of aircraft or component for which issued.

01.52. *Requirements for issuance of production certificates.*—

01.520. *Type certificate required.*—As one requisite to the issuance of a production certificate the applicant therefor shall hold a type certificate for the type of article to be manufactured or shall have secured the rights to manufacture such article under an existing type certificate.

01.521. *Production facilities.*—The applicant for a production certificate shall demonstrate to the satisfaction of the Secretary the adequacy of his production facilities, including qualified personnel, for the manufacture, in quantities, of aircraft or components which such production certificate is to cover. The production facilities shall be such as to insure the reproduction of articles of an exact similarity of type, structure, materials and workmanship with the specifications and other data forming the basis of the type certificate or type certificates for which the production certificate is issued.

01.522. *Inspection of facilities.*—The applicant for a production certificate shall offer full cooperation in respect of any inspection of facilities which may be made upon proper demand by any authorized representative of the Secretary prior and subsequent to the issuance of such production certificate.

01.523. *Inspection of aircraft.*—If the applicant for a production certificate is not the manufacturer of the aircraft which was subjected to the inspections and tests conducted in the fulfillment of the requirements for the type certificate issued, the first article manufactured by him under each production certificate shall satisfactorily undergo the inspection and flight tests required for the issuance of a type certificate.

01.53. *Issuance.*—Upon approval of an application duly made and proofs submitted a production certificate, specifying the type certificate numbers for which the production certificate is valid and whatever detailed inspection procedure may be required prior to the issuance of airworthiness certificates for aircraft manufactured under said production certificate, will be issued in an appropriate form.

01.54. *Certification under production certificate.*—Aircraft or component parts manufactured under a production certificate and in accordance with the terms thereof may be certificated as airworthy on the basis of the airworthiness rating of the original article of the type represented by the type certificate for which said production certificate was issued; provided, however, that each article shall satisfactorily undergo such inspections as may be required under the terms of said production certificate.

01.55. *Display.*—Any production certificate, including such papers and data as may be a part thereof, shall be presented for inspection upon the demand of any authorized representative of the Bureau and of any State or municipal official charged with enforcing local laws or regulations involving Federal compliance.

01.56. *Duration and nontransferability.*—

01.560. *Duration.*—A production certificate will be issued for an indeterminate period of time and shall remain effective so long as the aircraft or components for which it is issued are being manufactured in accordance with terms of such certificate and so long as manufacturing facilities and personnel are continuously maintained at the standards which formed the basis for issuance of such certificate, or until said certificate is sooner suspended or revoked, or canceled upon the written request of the holder thereof.

01.561. *Nontransferability.*—A production certificate is not transferable. However, such certificate may be reissued to a manufacturer other than the original holder thereof provided such other manufacturer meets all the requirements pertaining thereto.

01.57. *Suspension, revocation, cancellation and surrender.*—

01.570. *Suspension or revocation.*—A production certificate may be suspended or revoked in the event of unsatisfactory or unsafe performance in service of aircraft, engines, propellers or other aeronautical equipment manufactured under a production certificate, and by reason of any of the following on the part of the holder thereof:

01.5700. (a) The making of any false statement in an application for said certificate, or in any information accompanying the application, or in any report required by the Secretary.

01.5701. (b) Failure to make any report required by the Secretary.

01.5702. (c) Use or display of any production certificate or other official notification from the Bureau for a fraudulent purpose; or misrepresentation of any certificated product; or use or display of any production certificate or other official notification from the Bureau in any manner contrary to the public safety or interest.

01.5703. (d) Alteration of the basic design or specifications of an aircraft, engine, propeller or other aeronautical equipment for which a production certificate has been issued, without first having such alteration incorporated in



the type certificate on which the production certificate is based.

01.5704 (e). Refusal to submit to inspection of facilities, personnel or products upon proper demand by an authorized representative of the Secretary or to render any reasonable assistance in connection therewith.

01.5705 (f). Moral irresponsibility.

01.5706 (g). Violation of the Air Commerce Act or any rule or regulation duly issued thereunder.

01.571. *Surrender.*—Upon notice from the Secretary of the suspension or revocation of a production certificate, or in case of cancellation thereof, the holder thereof shall immediately return such certificate to the Secretary.

01.58. *Confidential nature of data.*—Technical data furnished by manufacturers or designers of aircraft, engines, propellers or other aeronautical equipment, in compliance with the procedure established for the issuance of a production certificate therefor, will be treated as confidential by all employees of the Department of Commerce for such time as the certificate is in force.

01.6. *Registration certificates.*—See CAR 00.

01.7. *Certificate rules.*—

01.70. *Operation of certificated aircraft.*—

01.700. No aircraft certificated as airworthy shall be flown, or authorized to be flown, in violation of the operating or other terms of its airworthiness certificate, nor in violation of any provision of CAR 60, nor unless its airworthiness has been maintained in accordance with CAR 01.72.

01.701. No aircraft certificated as experimental shall be flown, or authorized to be flown, in violation of the operating or other terms of its certificate, nor in violation of any provision of CAR 60.

01.702. No person shall be carried in flight in any aircraft certificated in the classification R or X (See CAR 02.111 and 02.112) except such members of the crew as are necessary for the operation thereof in accordance with the limitations stated in the pertinent certificate.

01.703. The registered owner or the operator of a certificated aircraft shall not permit it to be flown by any person other than one possessed of a pilot certificate valid for the type of aircraft and operation involved.

01.71. *Operation of damaged or altered certificated aircraft.*—

01.710. No flight of a certificated aircraft which has been damaged or altered shall be made, or authorized to be made, until the aircraft has been re-rated as to airworthiness in accordance with the provisions of CAR 18, or has been re-rated as an experimental aircraft.

01.711. When a certificated aircraft has undergone repairs or alterations as set forth in CAR 18.11, 18.12, 18.23, or 18.24, or when a new, old or re-conditioned engine has been installed therein, such aircraft shall be test flown before any passenger is carried therein.

01.72. *Maintenance of airworthiness.*—

01.720. After an airworthiness certificate has been issued to the owner of an aircraft, and between the times that it is inspected by a Bureau inspector for airworthiness and for conformity with approved specifications, the owner shall be charged with the duty of maintaining the aircraft in a good and proper state of repair and flying condition so that it shall continue at all times to be airworthy and to conform with such specifications.

01.721. *Line inspection.*—The owner of a certificated aircraft (other than an aircraft engaged in scheduled interstate or foreign passenger airline carrier operation for which inspection and maintenance requirements are provided elsewhere in these regulations) shall be charged with the duty of having such aircraft given a line inspection by a person possessed of a valid pilot or mechanic certificate, at least once in 7 days preceding flight, provided, however, that there shall be at least one inspection for each 25 hours of flying time. The result thereof shall be entered in the aircraft log-book over the signature of the person making such inspection. The line inspection so required shall be

made to ascertain the working condition and state of repair of the following:

01.7210 (a). open control wires, all control wires and pulleys open to inspection through apertures, and all hinges on control surfaces;

01.7211 (b). landing gear structure, wheels, fittings, and shock absorbers;

01.7212 (c). fuselage parts open to visual inspection;

01.7213 (d). main plane external bracing, including fittings and struts, external wires, cables, turnbuckles, and fabric or covering;

01.7214 (e). control surface fabric or covering;

01.7215 (f). engine exhaust manifolds and exhaust-pipe extensions (the engine shall be given a warming-up test, during which the proper functioning of the engine instruments shall be ascertained);

01.7216 (g). carburetors and fuel-feed lines open to visual inspection, to insure proper functioning;

01.7217 (h). cooling system and connections;

01.7218 (i). cowlings, to insure that the cowlings are properly secured and safetied, and

01.7219 (j). propellers, as to condition.

01.722. *Periodic inspection.*—The owner of a certificated aircraft shall be charged with the duty, after each 100 hours of flight of the aircraft, of having such aircraft given a periodic inspection by a person possessed of a valid mechanic certificate, and the result thereof shall be entered in the aircraft logbook by the person making such inspection. The periodic inspection shall be made to ascertain the working condition and state the repair of the following:

01.7220 (a). powerplant installation,

01.7221 (b). control systems throughout,

01.7222 (c). propeller alignment,

01.7223 (d). fuselage fittings open or openable to inspection, and

01.7224 (e). all items specified in paragraphs CAR 01.7210 through 01.7219.

01.723. The Bureau inspector or other authorized representative of the Secretary shall be permitted by the owner, operating agency or pilot of any certificated aircraft to inspect it at any time and place for the purpose of determining its flying condition and state of repair. For such purposes, the owner, operating agency or pilot shall give to such inspector or representative free and uninterrupted access to the aircraft and to the area or shelter where the aircraft is located.

01.7230. Upon the presentation for inspection of an aircraft for renewal of its airworthiness certificate, all inspection plates and cowlings shall have been removed and all parts cleaned. The aircraft and engine logbooks, in current form, and the aircraft certificate shall be presented at the same time.

01.73. *Log-Books.*—

01.730. *Aircraft log.*—The registered owner of a certificated aircraft shall maintain an aircraft log-book therefor and shall be responsible for recording in such log-book current reports of line and periodic inspections, the flight time of the aircraft, rigging changes in the aircraft, and repairs and alterations of the aircraft structure and of the propeller.

01.731. *Engine log.*—The registered owner of a certificated aircraft shall maintain an engine log-book for each engine installed therein and shall be responsible for recording in such log-book current reports of line and periodic inspections, the duration of the running time of the engine both on the ground and in the air, changes in the engine installation, and of the overhaul and alteration of the engine.

01.732. The log-books required in CAR 01.730 and 01.731 shall be carried in such aircraft at all times when it is away from the landing area regularly used as its base of operations, provided, however, that log-books for certificated airline aircraft may be maintained and kept at terminals.

01.74. *Aircraft flight reports.*—

01.740. The registered owner of a certificated aircraft engaged in flying (as other than a scheduled airline carrier)



shall, on the first day of January and of July of each year, transmit to the Secretary the following information:

01.7400 (a). A navigation summary report showing the hours flown in each kind of non-scheduled operation during the 6 months immediately preceding the rendering of the report, and

01.7401 (b). such other data as may be specified from time to time on forms provided for such purpose by the Secretary.

01.741. When a certificated aircraft is not flown during any semi-annual period ending on the last day of December or of June in any year, such fact shall be reported to the Secretary immediately on the termination of such period.

01.75. *Accident reports.*—When serious injury to a person or to property is suffered or when death results by virtue of the operation of a certificated aircraft, the registered owner or the pilot of such aircraft shall immediately report, by telephone or telegraph, to the Secretary as to the identification mark of the aircraft and the time and place of the accident. All accidents occurring in the operation of certificated aircraft which results in damage to the aircraft shall be immediately reported to the Secretary by the registered owner or the pilot on a form supplied for the purpose, except that this shall not apply in the case of gliders unless serious injury or death results to persons.

01.76. *Production reports.*—A manufacturer to whom a type, an approved type, or a production certificate has been issued shall file his affidavit with the Secretary on January 1 and July 1 of each year showing the number of aircraft, engines, propellers or other equipment, as the case may be, constructed in exact accordance with the terms of such certificate during the preceding 6 months. This report shall include the serial numbers or other identification marks of all the articles involved, the dates of manufacture and any other pertinent information.

## 02. AIRCRAFT IDENTIFICATION MARK

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## CHAPTER 02. AIRCRAFT IDENTIFICATION MARK

02.0. *Provision for issuance.*—Pursuant to the provisions of the Air Commerce Act declaring that the Government of the United States has, to the exclusion of all foreign nations, complete sovereignty of the airspace over the lands and waters of the United States, including the Canal Zone, and requiring the Secretary of Commerce to establish air traffic rules for the navigation, protection, and identification of aircraft, the following regulations are prescribed for the assignment, approval, issuance and display of identification marks.

02.1. *Character.*—An aircraft identification mark will consist of one or more Roman capital letters and a number.

02.10. *International symbol.*—The Roman capital letter N will appear first in the identification mark of aircraft of the United States.

02.11. *Classification symbol.*—The international symbol N will be followed in the mark by the Roman capital letter C, R, or X, or by a bar, for the purpose of classifying the aircraft as to its airworthiness, as follows:

02.110 (a). The letter C will classify an aircraft as complying fully with the airworthiness requirements of CAR 01 and 04, 05, 06, or 07, as the case may be, for the purpose of carrying persons or property, for or without hire.

02.111 (b). The letter R will classify an aircraft as complying in some limited respect with the airworthiness requirements of CAR 01 and 04, 05, 06, or 07, as the case may be. The certificate of an aircraft in this classification will specify the use, or uses, for which such aircraft is deemed airworthy, but such use, or uses, shall exclude passenger carrying, and shall be for industrial purposes only.

02.112 (c). The letter X will classify an aircraft as one which has been issued an experimental certificate in accordance with CAR 01.3. An aircraft so classified has been found by inspection to possess no apparent unairworthy features.

02.113 (d). The bar symbol, —, will classify the aircraft as one whose airworthiness rating has not been established. An aircraft so classified is an uncertificated aircraft.

02.12. *Number.*—The classification symbol will be followed in the mark by a number issued for purposes of further identification.

02.2. *Issuance.*—

02.20. *Assignment.*—The aircraft identification mark will be assigned by the Secretary at the time of issuance of the registration or the airworthiness certificate, will be inserted in the body of either thereof, as the case may be, and will be issued as a part thereof.

02.21. *Provisional assignment.*—Pending issuance by the Secretary a provisional assignment may be made by a Bureau inspector.

02.3. *Location for display.*—

02.30. *Conventional airplanes and gliders.*—The mark on such aircraft shall be located on the lower surface of the lower left wing and on the upper surface of the upper right wing. If, in a biplane, the lower left wing space is less than one-half that of the upper left wing, the mark shall be located on the lower surface of the upper left wing, as far to the left as is possible. The top of the letters and figures shall be toward the leading edge. The height shall be at least four-fifths of the mean chord; provided, however, that in the event four-fifths of the mean chord is more than 30 inches, the height of the letters and figures need not be more but shall not be less than 30 inches. In the case of a monoplane, the mark shall be displayed on the lower surface of the left wing and the upper surface of the right wing in the manner thus described. On gliders the letters or figures shall be displayed in the same manner and place prescribed for airplanes except the minimum height shall be 15 inches. The mark shall also be located on both sides of the vertical tail surface, or size as large as a 2-inch margin will permit.

02.31. *Unconventional aircraft.*—Marks on such aircraft will be located as deemed satisfactory by the Secretary upon examination of a three-view drawing to scale, of the aircraft.

02.32. *Airships.*—The mark on such aircraft shall be located on both sides at a distance back from the nose equal to one-fourth of the total airship length, and so located vertically as to lie halfway between the bottom line of the airship surface and the point of maximum beam. The height of the letters and figures shall be one-twelfth of the maximum cross-sectional circumference, but need not exceed four feet.

02.33. *Conventional balloons.*—The mark on such aircraft shall be located at two opposite points near but below the maximum horizontal perimeter. The height of the letters and figures shall equal at least one-twelfth of such perimeter, but need not exceed four feet.

02.34. *Unconventional balloons.*—The mark on such aircraft shall be located as deemed satisfactory by the Secretary.

02.4. *Lettering.*—

02.40. *Type.*—The width of the letters and figures (except the figure 1) shall be at least two-thirds of their height. The width of each stroke shall be at least one-sixth



of the height of the letters and figures, which shall be of uniform size.

02.41. *Color*.—The letters and numbers shall be painted on the aircraft in any color on any background provided there is a strong contrast, as deemed suitable by the Secretary.

02.42. *Legibility*.—Except with the approval of the Secretary, no other design, mark, symbol or description shall be placed upon an aircraft if such design, etc., modifies, adds to, detracts from, or confuses the assigned mark or destroys its legibility. The assigned marks shall be kept clean and clearly visible.

02.5. *Identification mark rules*.—

02.50. *Domestic aircraft*.—Every aircraft (except a foreign aircraft) entering the airspace over the lands and waters of the United States, including the Canal Zone, shall be possessed of and display an identification mark assigned and issued therefor by the Secretary.

02.51. *Foreign aircraft*.—Foreign aircraft shall be subject to the provisions of CAR 02.50 unless specifically given other authorization pursuant to Section 6 of the Air Commerce Act.

02.52. *Domestic aircraft for foreign delivery*.—An aircraft manufactured in the United States for delivery to a foreign purchaser may display appropriate and duly assigned and/or issued foreign identification marks or insignia and may be navigated for the sole purpose of delivery to said foreign purchaser by the most practical direct air route or for demonstration purposes for a limited time within the immediate vicinity of the manufacturer's airport on application made to and approved by the Secretary.

### 03. AIRCRAFT TITLE TRANSFER

#### 03.0 Provision for Issuance

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##### 03.2 Purchaser's Application for Registration Certificate

##### 03.3 Purchaser's Application for Aircraft Certificate

##### 03.4 Interim Status of Aircraft

##### 03.5 Interim Operation of Aircraft

### CHAPTER 03. AIRCRAFT TITLE TRANSFER

03.0. *Provision for issuance*.—Pursuant to the provisions of the Air Commerce Act requiring the Secretary of Commerce to provide for the granting of registration to aircraft eligible therefor, and to provide for the rating of aircraft as to airworthiness, the following regulations are made to provide for the situations arising from the transfer of title to aircraft.

03.1. *Seller's report of title transfer*.—On the date of transfer of title of an aircraft registered as an aircraft of the United States, the registered owner thereof shall report the transaction in writing to the Secretary on Form AC 03-1 supplied for the purpose, and shall surrender his registration certificate for said aircraft, properly executed as to transfer of title, to the purchaser.

03.2. *Purchaser's application for registration certificate*.—On or after the date of transfer of title of an aircraft registered as an aircraft of the United States the purchaser thereof who desires to register such aircraft as an aircraft of the United States, shall make application therefor to the Secretary in accordance with the provisions of CAR 00.2.

03.3. *Purchaser's application for aircraft certificate*.—On or after the date of transfer of title of an aircraft the purchaser thereof, who desires an aircraft certificate therefor, shall make application to the Secretary in accordance with the appropriate provisions of CAR 01.

03.4. *Interim status of aircraft*.—In the interval of time between the date of transfer of title of an aircraft of the United States and the date of issuance of a registration certificate for such aircraft to the purchaser thereof, as provided in CAR 03.2 such aircraft is unregistered and shall not be flown within the navigable airspace of the United States, unless such purchaser fully complies with the provisions of CAR 03.5.

03.5. *Interim operation of aircraft*.—Pending the completion of the record of transfer of title by the Secretary and

the issuance of a registration certificate and an aircraft certificate, if any, the purchaser, if a citizen of the United States, may operate the aircraft under the registration certificate and valid aircraft certificate, if any, previously issued to it, for a period of 60 days from the date of transfer upon the following conditions:

03.50 (a). On the date of transfer of title of an aircraft registered as an aircraft of the United States, the registered owner thereof shall have endorsed the date of transfer and name of the transferee in the blank space provided for such purpose on the face of the registration or aircraft certificate.

03.51 (b). On the date of transfer the proper application form shall have been either mailed to the Secretary or delivered directly to a designated Bureau inspector.

03.52 (c). The aircraft be operated in conformity with the terms of the valid aircraft certificate, if any, issued for such aircraft prior to the transfer of title.

03.53 (d). If the aircraft was issued an experimental certificate, special authority for its interim operation shall first be obtained from the Secretary.

### 04. AIRPLANE AIRWORTHINESS

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## CHAPTER 04. AIRPLANE AIRWORTHINESS

## 04.0. General.—

04.00. *Scope.*—Pursuant to the provisions of the Air Commerce Act requiring the Secretary of Commerce to provide for the rating of aircraft as to their airworthiness, the requirements hereinafter set forth shall be used as a minimum basis for establishing such rating for airplanes.

04.000. *Airworthiness certificate.*—The general requirements for the issuance of an airworthiness certificate, and other information concerning such certificates, are set forth in CAR 01. The airworthiness requirements which shall be used as a basis for the certification of airplanes are specified hereinafter. (See 04.003.)

04.001. *Type certificate.*—The general requirements for the issuance of a type certificate are set forth in CAR 01. In addition to the requirements hereinafter specified for an airworthiness certificate, the special requirements designated as (TC) shall apply when a type certificate is sought.

04.002. *Production certificate.*—The requirements for the issuance of, and the procedure for obtaining, a production certificate are set forth in CAR 01.

04.003. *Deviations.*—These requirements are based on the present development in the science of airplane design. Experience indicates that, when applied to conventional types of construction, they will result in an airworthy and well-proportioned aircraft. New types of aircraft and new types of construction may, however, incorporate features to which these requirements cannot be logically applied. In such cases, special consideration will have to be given the particular new problems involved. In cases where the deviation from conventional practice is small, approval may be granted if sufficient evidence is submitted to show that the proposed deviation will not be detrimental to the airworthiness of the design. When the deviation from conventional practice is considerable, special rulings covering the feature or features in question shall be obtained from the Secretary.

04.01. *Classification of airplanes.*—For the purpose of applying these requirements, airplanes are classified as follows:

- (a) *Normal.*—airplanes not included in class (b) below.
- (b) *Light.*—airplanes having a gross weight of less than 1000 pounds and a wing loading of not more than 6 pounds per square foot.

04.010. Such airplanes are further classified as:

- (a) Landplanes
  - (b) Seaplanes (Boat and Float Seaplanes)
  - (c) Amphibians (combination of (a) and (b))
- (See also CAR 01 for classification as to operation.)

04.02. *Airworthiness requisites.*—As a basis for an airworthiness rating, compliance with the quantitative and qualitative requirements herein with respect to the following factors shall be demonstrated to the Bureau in a manner satisfactory to the Secretary:

- (a) The structural strength of wing, tail and control surfaces, fuselage, engine mount, nacelles, fittings, control system and landing gear. (See CAR 04.2 and CAR 04.3.)
- (b) Pilot compartment, cabin and control arrangements. (See CAR 04.4 and CAR 04.5.)
- (c) Powerplant and powerplant installation. (See CAR 04.6.)
- (d) Equipment and instruments. (See CAR 04.5.)
- (e) Propellers. (See CAR 04.6.)
- (f) Detail design. (See CAR 04.4.)
- (g) Materials and workmanship. (See CAR 04.400.)
- (h) Flying characteristics and qualities. (See CAR 04.7.)
- (i) Safety features. (See CAR 04.4 and CAR 04.5.)

04.03. *Technical data required.*—When technical data are submitted as a basis for an airworthiness rating they shall include information which, in conjunction with suitable inspection and test procedure, will enable the Secretary to establish such rating.

04.030. *Submission to branch office.*—When data are submitted to a branch office of the Bureau, an extra copy of the three-view drawing, main assemblies and installations, drawing lists, applications and reports shall be included for the Washington office files.

04.031. *Data required for airworthiness certificate.*—The minimum data required as a basis for the issuance of an airworthiness certificate for a specific single airplane for which a type certificate is not sought or has not previously been issued, are as follows:

- (a) A three-view drawing of the airplane, to a designated scale, specifying the external dimensions, manufacturer's designation, engine model designation, design weight, empty weight, wing and control surface areas, seating arrangement, fuel and oil capacity, baggage capacity (in pounds) and equipment supplied.

(b) Such additional technical data as are deemed necessary by the Secretary to show compliance with the requirements of CAR 04.02.

04.032. *Data Required for Type Certificate (TC):* As a basis for type certification, the following technical data shall be submitted.

04.0320 (TC). *Drawings.*—A set of drawings shall be submitted in blueprint form, or equivalent. Drawings shall be folded to a size approximately 9" x 12", and shall contain at least the following information:

- (a) The manufacturer's designation of the original model to which each drawing applies.

(b) All dimensions essential to the reproduction of an identical airplane in respect to structural strength and dimensions.

(c) All dimensions essential for checking the structural analysis required in 04.0327.

(d) Specifications of all materials used in the primary structure (See CAR 04.131), including the guaranteed physical properties in the case of materials the strength properties of which are developed through manufacturing processes, and specifications of all bolts, nuts, rivets and similar standard parts essential to the strength of the structure.

(e) Details of the primary structure, seating arrangement, exists, control systems, powerplant installations, equipment installations and other factors affecting the airworthiness of the airplane, except that adequate photographs may be substituted for drawings of the powerplant installation, including cooling and exhaust systems. Such photographs shall be made from marked negatives indicating the dimensions and materials of the piping and fittings. In any case diagrammatic layouts of the fuel and oil systems shall be submitted.

(f) Revision blocks stating the nature of the revision and the date it was made, and the serial number of the first airplane manufactured in accordance with the revision.

(g) A three-view drawing of the airplane, to a designated scale, specifying only the external dimensions of the airplane (including dimensions and areas of wing and control surfaces) and the airplane and engine model designations.

04.0321 (TC). *Drawing list.*—A drawing list shall be submitted in duplicate, listing in numerical order or by suitable classification the number, title and original date of each drawing submitted under CAR 04.032. The drawing list shall include references to all drawings originally submitted in connection with applications for airworthiness rating of other models and which apply to the model in question without change. The drawing list shall also indicate, by letter, the latest revision of each revised drawing.

04.0322 (TC). *Equipment lists.*—Lists specifying the equipment supplied with each airplane shall be submitted. The location, weight, and model designation of each item of equipment, including the additional weight necessary for installation shall be specified.



04.0323 (TC). *Preliminary weight and balance report.*—A report shall be submitted in which the range of center of gravity locations for which rating is sought is determined versus weight and with respect to suitable reference planes or lines.

04.0324 (TC). *Balance diagram.*—The report required in CAR 04.0323 shall include a diagram showing the location of the centers of gravity of the component parts of the airplane and its contents, and the location of a suitable reference chord for the wing system, and the location of the assumed center of pressure of the horizontal tail. The locations of the above items shall be indicated by reference to suitable horizontal and vertical planes.

04.0325 (TC). *Weight table.*—The report required in CAR 04.0323 shall include a table or list of the weights of all component parts of the airplane and its contents.

04.0326 (TC). *Structural report.*—A structural report shall be submitted in which the strength of the structure is determined with reference to the strength requirements hereinafter specified. The structural report shall include the computations of the required limit loads and shall demonstrate the ability of the structure to develop the required factors of safety with respect to these loads either by analytical methods satisfactory to the Secretary or by reference to authenticated test data, or by a combination of both. (See CAR 04.3.) The structural report shall also include all computations necessary to prove compliance with the miscellaneous requirements hereinafter specified.

04.0327 (TC). *Structural analysis.*—Computations submitted as part of the structural report shall include a table, or tables, including the minimum margins of safety computed for all structural members and shall bear the signature of the responsible engineer or engineers.

04.0328 (TC). *Test reports.*—Test reports submitted as a part of, or referred to in, the structural report shall bear the signature of the Secretary's representative who witnessed the tests, except in the case of minor tests, in which case the applicant's certification that the report accurately represents the complete results of the tests will be accepted.

04.04. *Procedure when airworthiness certificate only is sought* (see also CAR 01).—

04.040. *General.*—The applicant shall prove, to the satisfaction of the Secretary, compliance with all pertinent airworthiness requirements. (See CAR 04.02.) The proofs submitted by the applicant shall include such computations as are necessary to determine the exact application of the airworthiness requirements to the airplane in question.

04.041. *Structural inspection.*—An official representative of the Secretary will conduct such inspections of the structure and methods of fabrication as are deemed necessary by the Secretary prior to completion of the airplane and will witness structural tests in compliance with these regulations. (See CAR 04.3023.)

04.042. *Flight tests.*—The airplane shall be subjected to such flight tests as are deemed necessary by the Secretary to prove compliance with the flight and operation requirements specified in CAR 04.7.

04.05. *Procedure for type certificate.*—

04.050. *Examination of data.*—

04.0500. *Partial data.*—Arrangements may be made with the Bureau for examination of the required technical data in partial units prior to the receipt of a complete file provided that each such unit is complete in itself, and further provided that there is no unreasonable time interval between the receipt by the Bureau of the various units necessary to complete the file.

04.0501. *Discontinuance of examination.*—Examination of any technical data, including drawings, submitted in connection with an application for airworthiness rating, will be discontinued if errors, omissions, or lack of references are found which, in the opinion of the Secretary, render the data unsatisfactory as a basis for proving compliance with the airworthiness requirements. The examination will be continued upon correction of the data to the Secretary's

satisfaction. Minor errors and omissions, the effects of which can be readily evaluated, will not constitute cause of discontinuing examination of technical data.

04.051. *Structural inspection.*—An official representative of the Secretary will conduct such inspections of the structure and methods of fabrication as are deemed necessary by the Secretary prior to completion of the airplane and will witness structural tests in compliance with these regulations. (See CAR 04.304.)

04.052. *Type inspection authorization.*—A type inspection will be authorized upon fulfillment of the following requirements:

(a) Completion of examination of the structural report and drawings and correction by the applicant of all errors and omissions which, in the opinion of the Secretary, must be corrected before authorization of the type inspection.

(b) Completion, and acceptance by the Bureau, of all structural tests required as part of the structural report or to prove compliance with the requirements herein specified.

(c) Submission of test reports conforming to the requirements of CAR 04.304 and approval of such reports by the Bureau.

04.053. *Type inspection procedure.*—The type inspection shall consist of a ground inspection and a flight test of an airplane built to conform with the technical data previously submitted and on which the authorization of the type inspection was based. The following sub-paragraphs shall be complied with in connection with the type inspection.

04.0530. *Affidavit of conformity.*—The manufacturer shall present to a designated inspector of the Bureau an affidavit of conformity (Form AC 04-1) in which his chief engineer or other responsible technical representative shall swear under oath that the airplane submitted for type inspection has been manufactured in accordance with the latest technical data submitted to and approved by the Secretary (including all revisions and additions required by the Secretary in connection with authorization of the type inspection) except for any deviations therefrom, which shall be listed and described.

04.0531. *Weight and balance report.*—The airplane shall be weighed and its balance determined in the presence of the inspector, and the manufacturer shall submit to such inspector a complete report covering the determination of the weights and center of gravity locations for which certification is desired.

04.0532. *Applicant's flight test report.*—Prior to, or at the time of, presentation of the airplane for flight tests, the applicant shall submit to the inspector a detailed report of flight tests of the airplane involved. This report shall be signed by the applicant's test pilot who shall certify that the airplane has been flown by him in all maneuvers required for proof of compliance with the flight requirements hereinafter specified and found to conform therewith, except that for very large airplanes this procedure may be modified as deemed necessary by the Secretary.

04.0533. *Ground inspection.*—Before conducting any flight tests, the inspector will complete the ground inspection to the extent that all items affecting the safety of flight have been found satisfactory.

04.0534. *Flight tests.*—The airplane shall be subjected to such flight tests as are necessary to prove compliance with the flight and operation requirements specified in CAR 04.7 and to supply the information required on Form AC 04-2.

04.0535. *Discontinuance of type inspection.*—If during any part of the ground inspection or flight test there is noted any unfavorable characteristic or defect which is considered sufficiently serious by the inspector to warrant discontinuing the type inspection until corrective measures have been taken by the applicant.

(a) the inspector will note each unsatisfactory item on Form AC 04-3 with sufficient detail so that it will be clear to all concerned;



(b) one copy of Form AC 04-3 will be transmitted to the manufacturer;

(c) the manufacturer shall advise the Bureau when the aircraft, incorporating the required changes, will be available for continuance of the type inspection, and

(d) the manufacturer shall furnish the Secretary with technical data descriptive of all structural changes except those of an obviously minor nature, and such changes shall be approved prior to resuming the type inspection.

**04.054. Certification of airplanes.**—The procedure specified in the following sub-paragraphs will be followed in certifying as to the airworthiness of an airplane.

**04.0540. Issuance of aircraft specification.**—Upon completion of all reports, tests and inspections required to prove compliance with the airworthiness requirements to the satisfaction of the Secretary and upon receipt of the certification of the inspector (or inspectors) who conducted the type inspection to the effect that the airplane inspected was found to be airworthy, together with properly executed inspection forms specified in the preceding paragraphs, an Aircraft Specification will be issued for the type and model of the airplane in question. The Aircraft Specification will certify as to the airworthiness of the type of airplane in question when manufactured and inspected in accordance with the provisions noted thereon.

**04.0541. Issuance of type certificates.**—A type certificate such as is described in CAR 01 will be issued to the applicant upon compliance with the requirements therein.

**04.0542. Authenticated data.**—As a part of the type certificate, the Secretary will furnish the applicant, upon issuance of such certificate, one set of drawing lists on which the seal of the Bureau is impressed. These lists shall show acceptance of the drawings as partial proof of the airworthiness of the type of airplane to which they apply.

**04.055. Confidential data.**—All technical data submitted by the applicant for the Bureau's file will be held confidential and will be used only in connection with the airworthiness rating of the airplane or airplanes to which such data apply; provided, however, that the Secretary may at his discretion make such use of the confidential data as is required in the interests of public safety. Access to confidential data will be provided to accredited representatives of the holder of, or applicant for, a pertinent type certificate. Confidential data will not be used for reference purposes in connection with the repair, alteration or remodeling of certificated airplanes by persons other than the holder of the pertinent type certificate without the written consent of such holder unless he is out of business or has given the Bureau blanket permission for such use.

**04.06. Changes, repair and alteration.**—

**04.060. Change, repair or alteration of certificated airplanes.**—Change, repair or alteration of a certificated airplane renders such airplane subject to re-rating as to airworthiness in accordance with CAR 18, but does not affect the type certificate on which the airworthiness certification may have been based.

**04.061. Changes affecting type certificate.**—The holder of a type certificate shall apply for approval of any specific change or revision of the approved drawings or specifications which, in the opinion of the Secretary, affect the airworthiness of the airplane and shall submit sufficient technical data in the form of strength calculations and strength tests, or both, to demonstrate continued compliance with the airworthiness requirements hereinafter specified. If, in the opinion of the Secretary, the changes are such as to affect the performance or operating characteristics, appropriate tests may be required. Upon satisfactory proof that the revisions do not render the airplane type unairworthy the Aircraft Specification may be modified to include airplanes embodying the approved changes, and sealed copies of the revised drawing list pages will be returned to the applicant.

**04.0610. Drawing changes.**—When a revised drawing is submitted to the Bureau and airplanes previously constructed according to the original drawing are not to be changed,

such revised drawing shall indicate the serial number of the first airplane to which the change applies. Corrected pages of the drawing lists shall be submitted in duplicate for each model to which the revision applies. Alternate installations shall be so designated and properly indicated on the drawing lists.

**04.0611. Minor changes.**—The suitability of a minor change will be judged on the basis of the airworthiness requirements which were in effect when the particular airplane model or type was originally certificated, unless the specific circumstances indicate the advisability of compliance with current requirements. Minor changes which obviously do not impair the structural strength or reliability of the airplane nor affect its flying characteristics may be approved by authorized Bureau inspectors without prior reference to the Washington Office. Shop drawings showing such changes shall be forwarded to the Bureau for record purposes.

**04.0612. Major changes.**—Major changes, such as the installation of an engine of a type other than that covered by the original type certificate, shall require the issuance of a new type certificate and may require compliance with current requirements at the discretion of the Secretary.

**04.0613. Changes by persons other than holder of type certificates.**—Changes such as described in CAR 04.061 when made by persons other than the holder of the type certificate are subject to the same procedure as that outlined in CAR 04.061 and pertinent sub-paragraphs, except that the written consent of the holder of the type certificate shall be obtained if it is desired to refer to technical data originally submitted to the Bureau in connection with application for type certificate. (See CAR 04.055.)

**04.06130.** If changes by persons other than the holder of the type certificate are to be made effective for all airplanes manufactured under the pertinent type certificate, the pertinent Aircraft Specification will be revised accordingly.

**04.06131.** If changes by persons other than the holder of the type certificate are to be incorporated only on airplanes owned or operated by the person or persons making the change, an amendment to the pertinent Aircraft Specification will be issued to cover the approved changes.

**04.1. Definitions.**—

**04.100. Weight, W.**—The total weight of the airplane and its contents.

**04.101. Design weight.**—The weight of the airplane assumed for purposes of showing compliance with the structural requirements hereinafter specified.

**04.1010. Minimum design weight.**—Weight empty with standard equipment, plus crew, plus fuel of .25 lb. per maximum (except take-off) horsepower, plus oil.

**04.102. Standard weight.**—The maximum weight for which the airplane is certificated as complying with all the airworthiness requirements for normal operations.

**04.103. Provisional weight.**—The maximum weight for which the airplane is certificated as complying with the airworthiness requirements as modified for scheduled air carriers in CAR 04.71.

**04.104. Design wing areas.**—The design wing area is the area bounded by the projection of the actual outline on the surface containing the wing chords, without deduction for the area blanketed by fuselage or nacelles. That part of the area which lies within the fuselage or nacelles is bounded by lateral lines connecting the intersections of the leading and trailing edges with the fuselage or nacelle, ignoring fairings or fillets.

**04.105. Design power, P.**—The total engine horsepower used in determining the maneuvering load factors and design level speed, V<sub>L</sub>. (See CAR 04.111 and 04.211.)

**04.106. Design wing loading, W/S.**—The design weight (CAR 04.101) divided by the design wing area (CAR 04.104).

**04.107. Design power loading, W/P.**—The design weight (CAR 04.101) divided by the design power. (See CAR 04.105 and Figure 04-3.)

**04.108. Air density,  $\rho$ .**—The mass density of the air through which the airplane is moving, in terms of the weight



of a unit volume of air divided by the acceleration of gravity. The symbol  $\rho_0$  denotes the mass density of air at sea level under standard atmospheric conditions and has the value of 0.002378 slugs per cubic foot. (See CAR 04.130 for definition of standard atmosphere.)

04.109. *True airspeed,  $V_t$* .—The velocity of the airplane, along its flight path, with respect to the body of air through which the airplane is moving.

04.110. *Indicated airspeed,  $V_i$* .— $V_t$ , the true airspeed multiplied by the term  $\sqrt{p/p_0}$ . (See CAR 04.108.)

04.111. *Design level speed,  $V_L$* .—The indicated airspeed in level flight at design gross weight when the design power (CAR 04.105) is delivered by the engine or engines. In estimating  $V_L$  for design purposes a suitable propeller efficiency shall be assumed. This value of  $V_L$  will be used as a basis for speed limitations. (See CAR 04.7430.)

04.112. *Design gliding speed,  $V_g$* .—The maximum indicated airspeed used in determining the flight loads. (See CAR 04.211.)

04.113. *Design stalling speed,  $V_s$* .—The computed indicated airspeed in unaccelerated flight based on the maximum lift coefficient of the wing and the design gross weight. The effects of slipstreams and nacelles shall be neglected in computing  $V_s$ . When high-lift devices are in operation the corresponding stalling speed will be denoted by  $V_{st}$ .

04.114. *Design flap speed,  $V_f$* .—The indicated airspeed at which maximum operation of high-lift devices is assumed. (See CAR 04.211.)

04.115. *Maximum vertical speed,  $V_m$* .—A fictitious value of indicated airspeed computed for unaccelerated flight in a vertical dive with zero propeller thrust.

04.116. *Design maneuvering speed,  $V_p$* .—The indicated airspeed at which maximum operation of the control surfaces is assumed. (See CAR 04.211.)

04.117. *Design gust velocity,  $U$* .—A specific gust velocity assumed to act normal to the flight path. (See CAR 04.2121.)

04.118. *Dynamic pressure,  $q$* .—The Kinetic energy of a unit volume of air.

$$\begin{aligned} q &= \frac{1}{2} \rho V_t^2 \text{ (in terms of true airspeed)} \\ &= \frac{1}{2} \rho V_i^2 \text{ (in terms of indicated airspeed)} \\ &= V^2 / 391 \text{ pounds per square foot, when } V \text{ is miles per} \\ &\quad \text{hour indicated airspeed.} \end{aligned}$$

(See CAR 04.108 for definition of  $\rho$ .)

04.119. *Load factor or acceleration factor,  $n$* .—The ratio of a load to the design weight. When the load in question represents the net external load acting on the airplane in a given direction,  $n$  represents the acceleration factor in that direction.

04.120. *Limit load*.—A load (or load factor, or pressure) which it is assumed or known may be safely experienced but will not be exceeded in operation.

04.121. *Factor of safety,  $j$* .—A factor by which the limit loads are multiplied for various design purposes.

04.122. *Ultimate factor of safety,  $j_u$* .—A specified factor of safety used in determining the maximum load which the airplane structure is required to support.

04.123. *Yield factor of safety,  $j_y$* .—A specified factor of safety used in connection with the prevention of permanent deformations.

04.124. *Ultimate load*.—A limit load multiplied by the specified ultimate factor (or factors) of safety. See above definitions and CAR 04.200.

04.125. *Yield load*.—A limit load multiplied by the specified yield factor (or factors) of safety. (See above definitions and CAR 04.201.)

04.126. *Strength test*.—A static load test in which the ultimate loads are properly applied. (See CAR 04.200 and CAR 04.3021.)

04.127. *Proof test*.—A static load test in which the yield loads are properly applied for a period of at least one minute. (See CAR 04.201.)

04.128. *Balancing loads*.—Loads by which the airplane is placed in a state of equilibrium under the action of external forces resulting from specified loading conditions. The state

of equilibrium thus obtained may be either real or fictitious. Balancing loads may represent air loads, inertia loads, or both. (See CAR 04.2210.)

04.129. *Aerodynamic coefficients,  $C_L$ ,  $C_M$ ,  $C_P$ , etc.*.—The coefficients hereinafter specified are those of the "absolute" (nondimensional) system adopted as standard in the United States. The subscripts N and C used hereinafter refer respectively to directions normal to and parallel with the basic chord of the airfoil section. Other subscripts have the usual significance. When applied to an entire wing or surface, the coefficients represent average values and shall be properly correlated with local conditions (load distribution) as required in CAR 04.217.

04.130. *Standard atmosphere (standard air)*.—Standard atmosphere refers to that variation of air conditions with altitude which has been adopted as standard in the United States. (See any aeronautics text book or handbook, or NACA Technical Report No. 218.)

04.131. *Primary structure*.—Those portions of the airplane which are essential to the distribution and transmission of the loads acting on the airplane in the specified loading conditions. Primary structure includes control systems, engine mounts, fittings, members transmitting local loads, auxiliary members used to support or strengthen other members carrying direct loads, coverings of wing and control surfaces, and all other structural components to which the above definition applies.

04.2. *Structural loading conditions*.—

04.20. *General structural requirements*.—

04.200. *Strength*.—The primary structure (See CAR 04.131) shall be capable of supporting the ultimate loads (See CAR 04.124) determined by the loading conditions and ultimate factors of safety hereinafter specified, the loads being properly distributed and applied.

04.201. *Deformations*.—The primary structure shall be capable of supporting without detrimental permanent deformations, for a period of at least one minute, the yield loads (See CAR 04.125) determined by the loading conditions and yield factors of safety hereinafter specified, the loads being properly distributed and applied. Where no yield factor of safety is specified a factor of 1.0 shall be assumed. In addition, temporary deformations which occur before the yield load is reached shall be of such a nature that their repeated occurrence will not weaken or damage the primary structure.

04.202. *Stiffness*.—The primary structure shall be capable of supporting the limit loads (See CAR 04.120) determined by the loading conditions hereinafter specified without deflecting beyond whatever limits may be hereinafter prescribed or which may be deemed necessary by the Secretary for the case in question.

04.203. *Proof of strength and rigidity*.—No general requirements, but see CAR 04.3 for specific requirements.

04.204. *Materials, fabrication, protection, etc.*.—No general requirements, but see CAR 04.4 for specific requirements.

04.21. *Flight loads*.—

04.210. *General*.—The airworthiness rating of an airplane with respect to its strength under flight loads will be based on the airspeeds and accelerations (from maneuvering or gusts) which can safely be developed in combination. For certain classes of airplanes the acceleration factors and gust velocities are arbitrarily specified hereinafter and shall be used for those classes. The airspeeds which can safely be developed in combination with the specified acceleration factors and gusts shall be determined in accordance with the procedure hereinafter specified and shall serve as a basis for restricting the operation of the airplane in flight (See CAR 04.743).

04.211. *Airspeeds*.—(See CAR 04.109 to 04.116 for definitions.) The design airspeeds shall be determined as follows:

$V_L$  shall correspond to design power in accordance with CAR 04.11.

$V_g$  shall not be less than  $V_L + K_g(V_m - V_L)$ , except that it need not be greater than either  $V_L + 100$  miles per hour



or 1.5  $V_L$ , whichever is lower.  $K_g$  is specified on Fig. 04-1.  $V_m$  is defined in CAR 04.115.

$V_f$  shall not be less than  $2V_{sf}$ .  $V_{sf}$  is defined in CAR 04.113.

$V_p$  shall not be less than  $V_{sf} - K_P(V_L - V_{sf})$ , except that it need not be greater than  $V_L$ .  $K_P$  is specified on Fig. 04-2.

(See CAR 04.2220, 04.2223 and 04.2230 for exceptions for multi-engine airplanes.)

04.212. *Load factors.*—The flight load factors specified hereinafter shall represent wing load factors. The net load factor, or acceleration factor, shall be obtained by proper consideration of balancing loads acting on the airplane in the specific flight conditions.

04.2120. *Maneuvering load factors.*—The limit maneuvering load factors specified hereinafter (see Fig. 04-3) are derived largely from experience with conventional types of airplanes and shall be considered as minimum values unless it can be proved, to the satisfaction of the Secretary, that the airplane embodies features of design which make it impossible to develop such values in flight, in which case lower values may be used subject to the approval of the Secretary.

04.2121. *Gust load factors.*—The gust load factors shall be computed on the basis of a gust of the magnitude specified, acting normal to the flight path, and proper allowance shall be made for the effects of aspect ratio on the slope of the lift curve. The gust velocities specified shall be used only in conjunction with the gust formulae hereinafter specified. The basic gust load factor ( $n$ ) need not exceed that corresponding to the maximum dynamic  $C_L$  obtainable under sudden changes of angle of attack. The following formula for the load factor added in encountering a gust shall be used for wings (See CAR 04.22 for tail surfaces).

$$\Delta n = \frac{KUVm}{575(W/S)}, \text{ where}$$

$\Delta n$  = limit load factor increment.

$K$  = gust reduction factor.

$= \frac{1}{2} (W/S)^{1/4}$ , but need not exceed 1.0.

$U$  = gust velocity, feet per second.

(Note that the "effective" sharp-edged gust equals  $KU$ )

$V$  = indicated airspeed, miles per hour.

$W/S$  = wing loading (CAR 04.106).

$m$  = slope of lift curve,  $C_L$  per radian, corrected for aspect ratio.

04.2122. *Factors of safety.*—The minimum factors of safety are specified for each loading condition. See also CAR 04.27 for multiplying factors of safety required in certain cases.

04.213. *Symmetrical flight conditions (flaps retracted).*—

04.2130. *General.*—The following flight conditions, together with Table 04-1, shall be considered as representing the minimum number of conditions required to cover a suitable range of symmetrical flight loadings.

04.2131. *Condition I (positive high angle of attack).*—The factors given in Table 04-1 and Fig. 04-3 for this condition shall be used. To provide for flight conditions critical for the front lift truss or its equivalent the aerodynamic characteristics  $C_N$ ,  $C_P$  (or  $C_M$ ) and  $C_c$  shall be determined as follows:

$$(a) C_{NI} = \frac{n_I(W/S)}{q_L} \quad (q_L \text{ is dynamic pressure corresponding to } V_L; \text{ see CAR 04.111 and 04.118.})$$

(b)  $C_c'$  = value corresponding to  $C_{NI}$ , or value equal to  $-.20 C_{NI}$ , whichever is greater negatively.

(c)  $C_P'$  = most forward position of the center of pressure between  $C_L = C_{NI}$  and  $C_L$  max.; when  $C_{NI}$  exceeds  $C_L$  max., the  $C_P$  curve shall be extended accordingly.

(d) For biplane combinations the  $C_P$  of the upper wing shall be assumed to be 2.5 per cent of the chord forward of its nominal position.

(e)  $C_M'$  = moment coefficient necessary to give the required  $C_P'$  in conjunction with  $C_{NI}$ .

04.21310. *Condition I, (positive high angle of attack modified).*—The smaller of the two values of  $C_c$  specified in CAR 04.2131 (b), and the most rearward  $C_P$  position in the range specified in CAR 04.2131 (c) shall also be investigated when Condition I is critical for the rear spar (or its equivalent) or if any portion of the front spar (or its equivalent) is likely to be critical in tension. Only the wings and wing bracing need be investigated for this condition.

04.2132. *Condition II (negative high angle of attack).*—The factors given in Table 04-1 for this condition shall be used, with the following provisions:

$$(a) C_{NII} = \frac{n_{II}(W/S)}{q_L}$$

(b)  $C_c$  = actual value corresponding to  $C_{NII}$ .

(c) When  $C_c$  is positive or has a negative value smaller than 0.02 it may be assumed to be zero.

(d)  $C_M$  = actual value corresponding to  $C_{NII}$ .

04.2133. *Condition III (positive low angle of attack).*—The factors given in Table 04-1 for this condition shall be used, with the following provisions:

$$(a) C_{NIII} = \frac{n_{III}(W/S)}{q_0} \quad (q_0 \text{ is dynamic pressure corresponding to } V; \text{ see CAR 04.118 and 04.112.})$$

(b)  $C_c$  = actual value corresponding to  $C_{NIII}$ .

(c) When  $C_c$  is positive or has a negative value smaller than 0.02 it may be assumed to be zero.

(d)  $C_M' = C_M - 0.01$ , where  $C_M$  is the actual value corresponding to  $C_{NIII}$ .

04.21330. *Condition III, (positive low angle of attack, modified).*—If the moment coefficient of the airfoil section at zero lift has a positive value, or a negative value smaller than 0.05, the effects of displaced ailerons on the moment coefficient shall be accounted for in Condition III for that portion of the span incorporating ailerons. To cover this point it will be satisfactory to assume that the basic value of  $C_M$  is equal to  $-0.05$  for that portion of the span incorporating ailerons, unless it is actually greater negatively. Only the wings and wing bracing need be investigated for this condition.

04.2134. *Condition IV (negative low angle of attack).*—The factors given in Table 04-1 for this condition shall be used, with the following provisions:

$$(a) C_{NIV} = \frac{n_{IV}(W/S)}{q_0}$$

(b)  $C_c$  = actual value corresponding to  $C_{NIV}$ .

(c) When  $C_c$  is positive or has a negative value smaller than 0.02 it may be assumed to be zero.

(d)  $C_M' = C_M - 0.01$ , where  $C_M$  is the actual value corresponding to  $C_{NIV}$ .

04.2135. *Condition V (inverted flight).*—The factors given in Table 04-1 for this condition shall be used, with the following provisions:

$$(a) C_{NV} = \frac{n_V(W/S)}{q_L}$$

(b)  $C_c' = 0$ .

(c)  $C_P' = 25\%$ .

(d) Only the rear (or single) lift truss system of externally braced wing structures need be investigated for this condition.

04.2136. *Condition VI (gliding).*—The factors given in Table 04-1 shall be used for this condition, with the following provisions:

(a)  $C_{NVI}$  = value corresponding to  $C_c$  max. (positive).

(b)  $C_c' = C_c$  max. (positive) + 0.01.

(c)  $C_M' = C_M - 0.01$ , where  $C_M$  is the actual value corresponding to  $C_{NVI}$ .

(d) The drag of nacelles and other items attached to the wings shall be conservatively estimated and



properly included in the investigation of this condition.

- (e) Only the wings and wing bracing need be investigated for this condition.

**04.214. Symmetrical flight conditions (flaps or auxiliary devices in operation).—**

**04.2140. General.**—When flaps or similar high-lift devices are installed on the wings, the design conditions shall be suitably modified to account for their use in flight. The modifications shall be based on the intended use of the flaps and the aerodynamic characteristics of the wing. The following conditions, together with Table 04-2, shall be considered as representing the minimum number of conditions required to cover a suitable range of symmetrical flight loadings in cases where the flaps are used only at relatively low airspeeds.

**04.2141. Condition VII (positive gust, flaps deflected).—**The factors given in Table 04-2 for this condition shall be used, with the following provisions:

(a) The most critical deflection of the flap shall be investigated.

(b) The magnitude and distribution of normal, chord and moment forces over the wing shall correspond to that which would be obtained in developing the specified limit gust load factor at the specified airspeed. The gust formula in CAR 04.2121 shall be used.

**04.2142. Condition VIII (negative gust, flaps deflected).—**The factors given in Table 04-2 for this condition shall be used, with the following provisions:

(a) The most critical deflection of the flap shall be investigated.

(b) The magnitude and distribution of normal, chord and moment forces over the wing shall correspond to that which would be obtained in encountering the specified limit gust load factor at the specified airspeed. The gust formula in CAR 04.2121 shall be used.

**04.2143. Condition IX (dive, flaps deflected).—**The factors given in Table 04-2 for this condition shall be used, with the following provisions:

(a) The most critical deflection of the flap shall be investigated.

(b) The load factor and the magnitude and distribution of normal, chord and moment forces over the wing shall correspond to the angle of attack at which the greatest rearward chord loads are produced on the wing structure.

(c) Only the wings and wing bracing need be investigated for this condition.

**04.215. Unsymmetrical flight conditions.—**

**04.2150. General.**—Pending the development of more rational methods, the following unsymmetrical flying conditions shall apply. In these conditions the angular inertia of the wings shall be assumed equal to zero, except that the effect of wing nacelles and landing gear may be considered.

**04.2151. Condition I<sub>u</sub>.**—Condition I (CAR 04.2131) shall be modified by assuming 100 per cent of the air load to be acting on one side of the airplane and 70 per cent on the other. For airplanes over 10,000 pounds gross weight the latter factor may be increased linearly with gross weight up to 80 per cent at 25,000 pounds.

**04.2152. Condition III<sub>u</sub>.**—Condition III (CAR 04.2133) shall be modified as described for Condition I<sub>u</sub> in CAR 04.2151, except that when Condition III<sub>u</sub> (CAR 04.21330) applies, the loading for the latter condition shall be substituted on the 100 per cent side.

**04.2153. Condition V<sub>u</sub>.**—Condition V (CAR 04.2135) shall be modified as described for Condition I<sub>u</sub> in CAR 04.2151.

**04.216. Special flight conditions.—**

**04.2160. Gust at reduced weight.**—The requirements for gust conditions (excepting tail surface gust conditions) under any loading between minimum and maximum design weight shall be met by primary structure critically loaded thereby.

**04.2161. Lift-wire cut.**—For wings employing wire bracing in the lift truss, Conditions I and III shall be investigated, using load factors  $n_I$  and  $n_{III}$  of one half the values specified for these conditions and assuming that any lift wire is out of action. This requirement does not apply to parallel double lift wires, for which case see CAR 04.273.

**04.2162. Drag-wire-cut.**—Drag struts in double-truss systems shall be designed to withstand the loads developed when the drag wire of the upper system in one bay and the drag wire of the lower system in the adjacent bay are each carrying their limit loads from any flight condition, the remaining wires in these two bays being assumed to be out of action. The minimum ultimate factor of safety shall be 1.5.

**04.2163. Unsymmetrical propeller thrust.**—The structure shall incorporate an ultimate factor of safety of 1.5 against failure due to loads caused by maximum (except take-off) power applied on one side of the plane of symmetry only, when power on the other side is off and the airplane is in unaccelerated rectilinear flight.

**04.2164. Wing tanks empty.**—If fuel tanks are supported by the wing structure, such structure and its bracing shall also be investigated for Conditions I, II, III and IV with wing tanks empty. The design weight may be reduced by 0.9 pound per certified maximum (except take-off) horsepower.

**04.217. Wing load distribution.**—The limit air loads and inertia loads acting on the wing structure shall be distributed and applied in a manner closely approximating the actual distribution in flight.

**04.22. Control surface loads.—**

**04.220. General.**—In addition to the flight loads specified in CAR 04.21 the primary structure shall meet the requirements hereinafter specified to account for the loads acting on the control surfaces. The following loading conditions include the application of balancing loads (CAR 04.128) derived from the symmetrical flight conditions and also cover the possibility of loading the control surfaces and systems in operating the airplane and by encountering gusts. See also CAR 04.27 for multiplying factors of safety required in certain cases.

**04.221. Horizontal tail surfaces.—**

**04.2210. Balancing.**—The limit load acting on the horizontal tail surfaces shall not be less than the maximum balancing load obtained from Conditions I, II, III, IV, VII and VIII. The factors given in Table 04-3 shall be used, with the following provisions:

(a)  $P$  (in Fig. 04-4) = 40% of net balancing load. (This requires the load on the fixed surface to be 140% of the net balancing load.) In any case  $P$  need not exceed that corresponding to a limit elevator control force of 150 pounds, applied by the pilot.

**04.2211. Maneuvering (horizontal surfaces).**—The factors specified in Table 04-3 and Fig. 04-5 for this condition shall be used, together with the following provisions:

(a) The limit unit loading in either direction need not exceed that corresponding to a load on the elevator control equal to the maximum limit control force (Table 04-6) and shall not be less than that corresponding to the minimum limit control force (Table 04-6) except as modified by paragraph (b) following.

(b) In any case the average limit unit loading shall not be less than the minimum pressure specified in Table 04-3 for this condition.

**04.2212. Damping (horizontal surfaces).**—The total limit load acting down on the fixed surface (stabilizer) in the maneuvering condition (CAR 04.2211) shall be applied in accordance with the load distribution of Fig. 04-6, acting in either direction. The load acting on the movable surface in the maneuvering condition may be neglected in determining the damping loads.

**04.2213. Tab effects (horizontal surfaces).**—When a tab is installed on the horizontal movable tail surface so that it



can be used by the pilot as a trimming device, the *limit* unit loading over the entire horizontal surfaces shall not be less than that corresponding to the application of the minimum *limit* control force (Table 04-6) together with maximum deflection of the tab in a direction assisting the control force. The factors specified in Table 04-3 for this condition shall be used.

#### 04.222. Vertical tail surfaces.—

04.2220. *Maneuvering*.—The factors given in Table 04-4 and Fig. 04-5 for this condition shall be used, with the following provisions:

(a) If the propeller axes are not in the plane of symmetry, the design speed shall not be less than the maximum speed in level flight with any engine inoperative.

(b) The *limit* unit loading in either direction need not exceed that corresponding to the maximum *limit* control force (Table 04-6) except as modified by paragraph (c) following.

(c) In any case the average *limit* unit loading shall not be less than the minimum pressure specified in Table 04-4 for this condition.

04.2221. *Damping (vertical surfaces)*.—The total *limit* load acting on the fixed surface (*fin*) in the maneuvering condition shall be applied in accordance with the load distribution of Fig. 04-6, acting in either direction. The load acting on the movable surface in the maneuvering condition may be neglected in determining the damping loads.

04.2222. *Gusts (vertical surfaces)*.—The gust conditions specified in Table 04-4 shall be applied, using the following formulae and provisions:

(a) The gust shall be assumed to be sharp-edged and to act normal to the plane of symmetry in either direction.  
(b) The average *limit* unit pressure,  $\bar{w}$ , developed in striking the gust shall be determined from the following formula:

$\bar{w} = UVm/575$ , where

$\bar{w}$  is in pounds per square foot,

$U$  is in feet per second,

$V$  is in miles per hour and

$m$  = slope of lift curve,  $C_L$  per radian, corrected for aspect ratio. The aspect ratio shall not be taken as less than 2.0 in any case.

(c) This condition applies only to that portion of the vertical surface which has a well-defined leading edge.

(d) The chord distribution extending over the fixed and movable surfaces shall simulate that for a symmetrical airfoil, except that the distribution in Fig. 04-6 may be used where applicable.

04.2223. *Tab effects (vertical surfaces)*.—When a tab is installed on the vertical movable tail surface so that it can be used by the pilot as a trimming device the *limit* unit loading over the entire vertical tail surfaces shall not be less than that corresponding to the maximum deflection of the tab together with simultaneous application of the following control force in a direction assisting the tab action:

For airplanes with all propeller axes in the plane of symmetry, zero.

For airplanes with propeller axes not in the plane of symmetry, 200 pounds.

The factors specified in Table 04-4 for this condition shall be used, with the following exception:

(a) If the propeller axes are not in the plane of symmetry, the design speed  $V_L$  specified in Table 04-4 may be reduced to the maximum speed in level flight with any engine inoperative.

04.2224. *Special cases (vertical surfaces)*.—A special ruling shall be obtained from the Secretary when an automatic pilot is used on airplanes with propeller axes not in the plane of symmetry.

#### 04.223. Ailerons.—

04.2230. *Maneuvering*.—The factors given in Table 04-5 and Fig. 04-7 for this condition shall be used, with the following provisions:

(a) If the propeller axes are not in the plane of symmetry, the design speed shall not be less than the maximum speed in level flight with any engine inoperative.

(b) The *limit* unit loading in either direction need not exceed that corresponding to the maximum control force (Table 04-6) resisted by only one aileron, except as modified by paragraph (c) following.

(c) In any case the average *limit* unit loading shall not be less than the minimum pressure specified in Table 04-5 for this condition.

04.2231. *Tab effects (ailerons)*.—(Applies only to airplanes with propeller axes not in the plane of symmetry.) When a tab is installed on one or both ailerons so that it can be used by the pilot to assist in moving the ailerons, the *limit* unit loading over both ailerons shall be of sufficient magnitude and in such direction as to hold the ailerons in equilibrium with the tab or tabs deflected to the maximum position. The factors specified in Table 04-5 for this condition shall be used.

04.2232. *Flying conditions (ailerons)*.—The ailerons and their control system shall be capable of meeting all requirements specified in the basic symmetrical flying conditions so far as the latter produce symmetrical loads on the ailerons.

04.224. *Wing flaps*.—Wing flaps shall be loaded in accordance with Conditions VII and VIII (CAR 04.2141 and 04.2142) and in addition shall be capable of developing an *ultimate* factor of safety of at least 1.5 with respect to any intermediate conditions which are more severe for any part of the flap or its operating mechanism.

04.225. *Tabs*.—The *limit* forces acting on control-surface tabs shall be determined from the most severe combination of airplane speed and tab normal force coefficient likely to be obtained for any usable loading condition of the airplane and at speeds up to the design gliding speeds,  $V_G$ . An *ultimate* factor of safety of at least 1.5 shall be maintained.

04.226. *Special devices*.—Special rulings shall be obtained from the Secretary in connection with the design and analysis of wing-slot structures, spoilers, unconventional ailerons, auxiliary airfoils and similar devices. Requests for special rulings shall be accompanied by suitable drawings or sketches of the structure in question, together with general information and an outline of the method by which it is proposed to determine the structural loading.

#### 04.23. Control system loads.—

04.230. *General*.—All control systems shall be designed for *limit* loads 25 per cent greater than those corresponding to the *limit* loads specified for the control surfaces to which they are attached, assuming the movable surface to be in that position which produces the greatest load in the control system, except that the maximum and minimum control force limits in Table 04-6 shall apply as hereinafter specified. The factors of safety specified in Table 04-6 shall be used. See also CAR 04.27 for multiplying factors of safety required in certain cases. See also CAR 04.331 for operation requirements for control systems.

04.2300. The forces in the control wires or push rods operating the movable surfaces shall be computed and their effect on the rest of the structure shall be investigated and allowed for in the design of such structure.

04.231. *Elevator systems*.—In applying CAR 04.230 the control force specified in Table 04-6 and Fig. 04-8 shall be assumed to act in a fore-and-aft direction and shall be applied at the grip of a control stick, or shall be equally divided between two diametrically opposite points on the rim of a control wheel.

04.232. *Rudder systems*.—In applying CAR 04.230 the control force specified in Table 04-6 shall be assumed to act in a direction which will produce the greatest load in the control system and shall be applied at the point of contact of the pilot's foot.



**04.233. Aileron systems.**—In applying CAR 04.230 it shall be assumed that the ailerons are loaded in opposite directions. The control force specified in Table 04-6 and Fig. 04-9 shall be assumed to act in a lateral direction at the grip of a control stick, or shall be assumed to act as part of couple equal to the specified force multiplied by the diameter of a control wheel. The following assumptions shall be made:

(a) For nondifferential ailerons, 75 per cent of the stick force or couple shall be assumed to be resisted by a down aileron, the remainder by the other aileron; also, as a separate condition, 50 per cent shall be assumed to be resisted by an up aileron, the remainder by the other aileron.

(b) For differential ailerons, 75 percent of the stick force or couple shall be assumed to be resisted by each aileron in either the up or down position, or rational assumptions based on the geometry of the system shall be made.

**04.234. Flap and tab control systems.**—In applying CAR 04.230 suitable minimum manual forces shall be assumed to act on flap and tab control systems and other similar controls.

**04.24. Ground loads.**—

**04.240. General.**—The following conditions represent the minimum amount of investigation required for conventional (tail down type) landing gear. For unconventional types it may be necessary to investigate other landing attitudes, depending on the arrangement and design of the landing gear members. Consideration will be given to a reduction of the specified *limit* load factors when it can be proved that the shock absorbing system will positively limit the acceleration factor to a definite lower value in the drop test specified in CAR 04.2411. The minimum factors of safety are specified for each loading condition. See also CAR 04.27 for multiplying factors of safety required in certain cases.

**04.241. Level landing.**—The minimum *limit* load factor is specified in Fig. 04-10. The resultant of the ground reaction shall be assumed to be a force lying at the intersection of the plane of symmetry and a plane in which are located the axles and the center of gravity of the airplane less chassis. The propeller axis (or equivalent reference line) shall be assumed horizontal and the basic value of the vertical component of the resultant of the ground reaction shall be equal to the gross weight of the airplane minus chassis and wheels. The horizontal component shall be of the magnitude required to give the resultant force the specified direction except that it need not be greater than 25 per cent of the vertical component. The resultant of the ground reaction shall be assumed to be divided equally between wheels and to be applied at the axle at the center of the wheel. The shock-absorber unit and tires shall be assumed to be deflected to half their total travel, unless it is apparent that a more critical arrangement could exist. The minimum *ultimate* factor of safety shall be 1.5.

**04.2410.** If a sliding element instead of a rolling element is used for the landing gear, a horizontal component of one-half of the vertical component shall be used to represent the effect of ground friction, except that ski gear which is designed and used only for landing on snow and ice may be designed for the same horizontal component as wheel gear.

**04.2411. Energy absorption.**—The level landing condition specified in CAR 04.241 shall be assumed to be produced by a free drop, in inches, equal to 0.36 times the calculated stalling speed ( $V_s$ ) in miles per hour, except that the height of free drop shall not be less than 18 inches for airplanes employing devices which increase the normal sinking speed, but need not exceed 18 inches when such devices are not employed. The height of free drop is measured from the bottom of the tire to the ground, with the landing gear extended to its extreme unloaded position. (See CAR 04.340 and 04.440.)

**04.242. Three-point landing.**—The minimum *limit* load factor is specified in Fig. 04-10. The value of the sum of the static ground reactions shall be the gross weight of the airplane less chassis. The total load shall be divided between the chassis and tail skid or wheel in inverse proportion to the distances, measured parallel to the ground line, from the center of gravity of the airplane less chassis to the points of contact with the ground. The load on the chassis shall be divided equally between wheels. Loads shall be assumed to be perpendicular to the ground line in the three-point landing attitude, with all shock absorbers and tires deflected to the same degree as in level landing. The tail wheel or skid installation shall also be investigated for this condition. The minimum *ultimate* factor of safety shall be 1.5.

**04.2420. Energy absorption.**—The three-point landing condition specified in CAR 04.242 shall be assumed to be produced by a free drop as specified under CAR 04.2411. This requires shock absorption by both main wheels and tail wheel (or skid). (See CAR 04.340 and 04.440.)

**04.243. Side load.**—The minimum *limit* load factor shall be 0.667. The weight of the airplane shall be assumed to act on one wheel in a direction perpendicular to the ground. In addition, a side component of equal magnitude shall be assumed to act inward and normal to the plane of symmetry at the point of contact of the wheel, and an aft component equal to 0.55 times the vertical component shall be assumed to act parallel to the ground at such point. The airplane shall be assumed to be in a three-point attitude with the shock absorbers deflected to their static position and the tire deflected to one-quarter the nominal diameter of its cross section. The minimum *ultimate* factor of safety shall be 1.5.

**04.244. One-wheel landing.**—An investigation of the fuselage structure is required for a one-wheel landing, in which only those loads obtained on one side of the fuselage in the level landing condition are applied. The resulting load factor is therefore one-half of the level landing load factor. (This condition is identical with the level landing condition insofar as the landing gear structure is concerned.) The minimum *ultimate* factor of safety shall be 1.5.

**04.245. Braked landing.**—The minimum *limit* load factor shall be 1.33. Airplanes equipped with brakes shall be investigated for the loads incurred when a landing is made with the wheels locked and the airplane is in an attitude such that the tail skid or wheel just clears the ground. The weight of the airplane less chassis shall be assumed to act on the wheels in a direction perpendicular to the ground line in this attitude. On addition, a component parallel to the ground line shall be assumed to act at the point of contact of the wheels and the ground, the magnitude of this component being equal to the weight of the airplane less chassis times a coefficient of friction of 0.55. The tire in all cases shall be assumed to have deflected not more than one-quarter the nominal diameter of its cross section, and the deflection of the shock absorbers shall be the same as in level landing. The minimum *ultimate* factor of safety shall be 1.5.

**04.246. Side loads on tail wheel or skid.**—Suitable assumptions shall be made to cover side loads acting on tail skids or tail wheels which are not free to swivel or which can be locked or steered by the pilot.

**04.247. Complete turn-over.**—The *ultimate* load factor for this condition shall be 4.5. The airplane shall be assumed to be inverted and the cabane structure (or its equivalent) shall be assumed to carry the entire load acting normal to the thrust line (or equivalent reference line). In cases where a wing is above the fuselage and braced by more than one cabane lift truss, at least one truss shall be designed for the entire load. The superstructure shall also be capable of resisting a total *ultimate* load of at least three-fourths the weight of the airplane, acting either forwardly or rearwardly parallel to the thrust line or wing chord and suitably divided between the uppermost points of the side trusses of the cabane or equivalent structure. Partial failure of the struc-



ture under these conditions is permissible provided that the specified *ultimate* loads can be resisted without endangering the occupants, assuming safety belts to be fastened. (See also CAR 04.460.)

#### 04.25. Water loads.—

04.250. *General.*—The following requirements shall apply to the entire airplane, but have particular reference to hull structures, wings, nacelles, and float supporting structure. The requirements for certification of floats as individual items of equipment are specified in CAR 15. The minimum factors of safety are specified for each loading condition. See also CAR 04.27 for multiplying factors of safety required in certain cases. Detail design requirements for hulls and floats are specified in CAR 04.45.

04.251. *Landing with inclined reactions (float, sea-planes).*—The vertical component of the *limit* load factor shall be 4.20 except that it need not exceed a value given by the following formula:

$$n = 3.0 + 0.133 (W/S).$$

The propeller axis (or equivalent reference line) shall be assumed to be horizontal and the resultant water reaction to be acting in the plane of symmetry and passing through the center of gravity of the airplane less floats and float bracing but inclined so that its horizontal component is equal to one-quarter of its vertical component. The forces representing the weights of and in the airplane shall be assumed to act in a direction parallel to the water reaction. The weight of the floats and float bracing may be deducted from the gross weight of the airplane.

04.2510. For the design of float attachment members, including the members necessary to complete a rigid base truss through the fuselage, the minimum *ultimate* factor of safety shall be 1.85. For the remaining structural members the minimum *ultimate* factor of safety shall be 1.50.

04.252. *Landing with vertical reactions (float sea-planes).*—The *limit* load factor shall be 4.33, acting vertically, except that it need not exceed a value given by the following formula:

$$n = 3.0 + 0.133 (W/S).$$

The propeller axis (or equivalent reference line) shall be assumed to be horizontal, and the resultant water reaction to be vertical and passing through the center of gravity of the airplane less floats and float bracing. The weight of the floats and float bracing may be deducted from the gross weight of the airplane.

04.253. *Landing with side load (float seaplanes).*—The vertical component of the *limit* load factor shall be 4.0, to be applied to the gross weight of the airplane less floats and float bracing. The propeller axis (or equivalent reference line) shall be assumed to be horizontal and the resultant water reaction shall be assumed to be in the vertical plane which passes through the center of gravity of the airplane less floats and float bracing and is perpendicular to the propeller axis. The vertical load shall be applied through the keel or keels of the float or floats, and evenly divided between the floats when twin floats are used. A side load equal to one-fourth of the vertical load shall be applied along a line approximately half-way between the bottom of the keel and the level of the water line at rest. When built-in struts are used, check calculations shall be made for the built-in struts with the side load at the level of the water line at rest. When twin floats are used, the entire side load specified shall be applied to the float on the side from which the water reaction originates. The minimum *ultimate* factor of safety shall be 1.50.

04.254. *Step landing (boat seaplanes).*—The aircraft shall be in such an attitude that the propeller axis (or equivalent reference line) is horizontal and shall be assumed to be supported by a vertical buoyant force distributed over an area extending from the step forward to a point half-way between the step and the forward end of the normal load water line. Such area may be assumed to be a rectangle whose width is equal to the full projected width of the bottom at the step.

The load on such area shall be so distributed that its intensity is 50 per cent greater at the keel than at the chine and 50 per cent greater on the section at the step than on the forward section. The volume of the prismatic loading curve so obtained, from which the intensities may be computed, shall equal the gross weight of the airplane times a *limit* load factor of 5.33. The minimum *ultimate* factor of safety shall be 1.5.

(a) For this condition and load factor:

$$nW = \frac{25abL}{16}, \text{ where}$$

$n$  = *limit* load factor = 5.33,

$a$  = intensity of loading at the chine at the forward section,

$b$  = the beam and

$L$  = half the length of the load water line forward of the step.

The centroid of this loading may be assumed to be on the keel  $8L/15$  from the forward edge of the load, and the resultant water reaction shall pass through this centroid and the center of gravity of the airplane.

(b) The forces representing the weights of and in the airplane shall act in a direction parallel to the water reaction.

04.255. *Two-wave landing (boat seaplane).*—The aircraft shall be assumed to be supported by vertically applied up loads at each end of the load water line, the magnitude of each load being such that the resultant load passes through the main step and equals the gross weight of the airplane. The *limit* shear loads and bending moments shall be computed by assuming the gross weight of the airplane to be concentrated at the step and omitting all panelpoint loads. The structure at the point of application of the external loads need not be investigated for local stresses in this condition. The minimum *ultimate* factor of safety shall be 1.50.

04.256. *Bottom loading (boat seaplane).*—The bottom plating, stringers, frames and adjoining structure shall be investigated for the *limit* unit loading determined by the following conditions, using a minimum *ultimate* factor of safety of 1.5:

(a) The *limit* unit loading for that portion of the hull bottom just forward of the main step shall be that determined from CAR 04.254.

(b) The area from the forward end of the normal load water line to a point half-way between the step and the forward end of the normal load water line shall be designed to support a *limit* load having the unit pressure found at the forward portion of the chine in CAR 04.254.

(c) The area extending from the step to the rear end of the normal load water line shall be designed to support a *limit* load having a unit pressure equal to 50 per cent of the average *limit* unit pressure found in CAR 04.254.

04.257. *Seaplane float loads.*—Each main float of a float seaplane shall carry the following loads when supported at the attachment fittings as installed on the airplane. The minimum *ultimate* factor of safety shall be 1.5.

(a) A *limit* load, acting upward, applied at the bow end of the float and of magnitude equal to one-half of that portion of the airplane gross weight normally supported by the particular float.

(b) The *limit* load specified in paragraph (a), above, acting upward at the stern.

(c) A *limit* load, acting upward, applied at the step and of magnitude equal to 1.33 times that portion of the airplane gross weight normally supported by the particular float.

04.2570. *Seaplane float bottom loads.*—Main seaplane float bottoms shall be designed to withstand the following loads. The minimum *ultimate* factor of safety shall be 1.5.

(a) A *limit* load of at least 5.33 pounds per square inch over that portion of the bottom lying between the first



step and a section at 25 per cent of the distance from the step to the bow.

(b) A *limit* load of at least 2.67 pounds per square inch over that portion of the bottom lying between the section at 25 per cent of the distance from the step to the bow and a section at 75 per cent of the distance from the step to the bow.

(c) A *limit* load of at least 2.67 pounds per square inch over that portion of the bottom lying between the first and second steps. If only one step is used, this load shall extend over that portion of the bottom lying between the step and a section at 50 per cent of the distance from the step to the stern.

04.258. *Wing-tip float loads.*—Wing-tip floats and their attachment, including the wing structure, shall be analyzed for each of the following conditions, using a minimum *ultimate* factor of safety of 1.5:

(a) A *limit* load acting vertically up at the completely submerged center of buoyancy and equal to three times the completely submerged displacement.

(b) A *limit* load inclined upward at 45° to the rear and acting through the completely submerged center of buoyancy and equal to three times the completely submerged displacement.

(c) A *limit* load acting parallel to the water surface (laterally) applied at the center of area of the side view and equal to one and one-half times the completely submerged displacement.

04.2580. The primary wing structure shall incorporate sufficient extra strength to insure that failure of wing-tip float attachment members occurs before the wing structure is damaged.

04.259. *Miscellaneous water loads.*—

04.2590. *Seawing loads.*—Special rulings shall be obtained from the Secretary for the strength requirements for seawings.

04.26. *Special loading conditions.*—

04.260. *Engine torque.*—In the case of engines having five or more cylinders the stresses due to the torque load shall be multiplied by a *limit* load factor of 1.5. For 4, 3 and 2 cylinder engines the *limit* load factors shall be 2, 3 and 4 respectively. The torque acting on the airplane structure shall be computed for the take-off power, and the propeller speed corresponding thereto, for which the aircraft is certificated. (See CAR 04.744.) The engine mount and forward portion of the fuselage and nacelles shall be designed for this condition. The minimum *ultimate* factor of safety shall be 1.5, except that higher factors may be prescribed by the Secretary when it appears necessary to make special provision for conditions such as vibration, stress concentration and fatigue.

04.261. *High angle of attack and torque.*—The *limit* loads determined from CAR 04-260 shall be considered as acting simultaneously with 75 per cent of the *limit* loads determined from Condition I (CAR 04.2131). The engine mount, nacelles and forward portion of the fuselage (when a nose engine is installed) shall be designed for this condition. The minimum *ultimate* factor of safety shall be 1.5.

04.262. *Side load on engine mount.*—The *limit* load factor for this condition shall be equal to one-third of the *limit* load factor for Flight Condition I (CAR 04.2131) but shall in no case be less than 1.33. The engine mount and forward section of the fuselage and nacelles shall be analyzed for this condition, considering the *limit* load to be produced by inertia forces. The minimum *ultimate* factor of safety shall be 1.5.

04.263. *Up load on engine mount.*—For engine mounts the *limit* load in each member shall be arbitrarily assumed as 50 per cent of that in the level landing condition but of opposite sign. The minimum *ultimate* factor of safety shall be 1.5.

04.264. *Passenger loads.*—Passenger loads in the accelerated flight conditions shall be computed for a standard passenger weight of 170 pounds and a minimum *ultimate* factor of safety of 1.50 shall be used, except that seats and berths need not be designed for the reduced weight gust conditions specified in CAR 04.2160. This shall not exempt the primary structure from such gust conditions.

04.2640. Structures to which safety belts are attached shall be capable of withstanding an *ultimate* load of 1,000 pounds per person applied through the safety belt and directed upward and forward at an angle of 45 degrees with the floor line.

04.265. *Local loads.*—The primary structure shall be designed to withstand local loads caused by dead weights and control loads. Baggage compartments shall be designed to withstand loads corresponding to the maximum authorized capacity. The investigation of dead weight loads shall include a sufficient number of reduced weight gust conditions to insure that the most severe combinations have been investigated. See CAR 04.90 for standard weights.

04.266. *Rigging loads.*—Structures braced by wires (or tie-rods) shall be capable of developing an *ultimate* factor of safety of 1.5 with respect to the *limit* loads due to rigging the wires to 20 per cent of their rated strength (strength of wire, not terminal). When the structure is such that all wires cannot be simultaneously rigged to 20 per cent of their rated loads, a rigging condition shall be assumed in which the average of the rigging loads, expressed in per cent, equals 20. (See also CAR 04.274.) The above condition need not be superimposed on other loading conditions, but the Secretary may require additional investigation for residual rigging loads when such investigation appears necessary. (See also CAR 04.315.)

04.267. *Air loads on struts.*—External wing-brace struts which are at an angle of more than 45 degrees with the plane of symmetry and which have a cross-sectional fineness ratio of more than 3 shall be assumed to act as lifting airfoils and shall be designed to carry the resultant transverse loads in combination with the specified axial loads. In computing the *limit* loads the strut sections shall be assumed to have a normal force coefficient equal to 1.0 and the total air load shall be based on the exposed area of the strut. The chord components and vertical reactions of such air load and the lift contributed by the strut shall not be considered in the analysis of the wing.

04.27. *Multiplying factors of safety.*—

04.270. *General.*—In addition to the minimum factors of safety specified for each loading condition, the multiplying factors specified in Table 04-7 and the following paragraphs shall be incorporated in the structure. The total factor of safety required for any structural component or part equals the minimum factor of safety specified for the loading condition in question multiplied by the factors of safety hereinafter specified, except that certain multiplying factors may be included in others, as indicated in Table 04-7.

04.271. *Fittings.*—All fittings in the primary structure shall incorporate the multiplying factor of safety specified in Table 04-7. For this purpose fittings are defined as parts used to connect one primary member to another and shall include the bearing of those parts on the members thus connected. Continuous joints in metal plating and welded joints between primary structural members are not classified as fittings. (See also CAR 04.4030 and 04.4031.)

04.272. *Castings.*—All castings used in the primary structure shall incorporate a multiplying factor of safety not less than that specified in Table 04-7.

04.273. *Parallel double wires.*—When parallel double wires are used in wing lift trusses each wire shall incorporate a multiplying factor of safety not less than that specified in Table 04-7.

04.274. *Wires at small angles.*—Wire or tie-rod members of wing or tail surface external bracing shall incorporate a multiplying factor of safety computed as follows:



$K=L/2R$  (except that  $K$  shall not be less than 1.0), where

$K$ =the additional factor,

$R$ =the reaction resisted by the wire in a direction normal to the wing or tail surface plane, and

$L$ =the load required in the wire to balance the reaction  $R$ .

04.275. *Double drag trusses.*—Whenever double drag trussing is required by CAR 04.412, all drag wires shall incorporate a multiplying factor of safety varying linearly from 3.0, when the ratio of overhang to root chord of overhang is 2.0 or greater, to 1.20 when such ratio is 1.0 or less, assuming an equal division of drag load between the two systems.

04.276. *Torque tubes used as hinges.*—When steel torque tubes are employed in direct bearing against strap-type hinges they shall incorporate a multiplying factor of safety at the hinge point not less than that specified in Table 04-7. (See also CAR 04.422.)

04.277. *Control surface hinges and control system joints.*—Control surface hinges and control system joints subjected to angular motion, excepting ball or roller bearings and AN standard parts used in cable control systems, shall incorporate multiplying factors of safety not less than those specified in Table 04-7 with respect to the *ultimate* bearing strength of the softest material used as a bearing. For ball or roller bearings a *yield* factor of safety of 1.0 with respect to the manufacturer's non-Brinell rating is considered sufficient to provide an adequate *ultimate* factor of safety.

04.278. *Wire sizes.*—(See CAR 04.403, 04.4032 and 04.412.)

04.3. *Proof of structure.*—

04.30. *General.*—Proof of compliance with the loading requirements outlined in CAR 04.2 shall be made in a manner satisfactory to the Secretary and may consist of structural analyses, load test, flight tests, references to previously approved structures, or combinations of the above. Any condition which can be shown to be noncritical need not be further investigated.

04.300. *Proof of structural analysis.*—Structural analyses will be accepted as complete proof of strength only in the case of structural arrangements for which experience has shown such analyses to be reliable. References shall be given for all methods of analysis, formulae, theories and material properties which are not generally accepted as standard. The acceptability of a structural analysis will depend to some extent on the excess strength incorporated in the structure.

04.3000. The structural analysis shall be based on guaranteed minimum mechanical properties of the materials specified on the drawings, except in cases where exact mechanical properties of the materials used are determined.

04.3001. The effects of welding, form factors, stress concentrations, discontinuities, cut-outs, instability, end fixity of columns and vibration shall be accounted for when such factors are present to such an extent as to influence the strength of the structure.

04.301. *Combined structural analysis and tests.*—In certain cases it will be satisfactory to combine structural analysis procedure with the results of load tests of portions of the structure not subject to accurate analysis. In such cases test results shall be reduced to correspond to the mechanical properties of the materials actually used in the airplane. When a unit other than the specific one tested is incorporated in the airplane presented for certification, test results shall be reduced to correspond to the minimum guaranteed mechanical properties of the materials specified on the drawings.

04.302. *Load tests.*—Proof of compliance with structural loading requirements by means of load tests only is acceptable provided that strength and proof tests (See CAR 04.126 and 04.127) are conducted to demonstrate compliance with CAR 04.200 and 04.201, respectively, and further provided that the following sub-paragraphs are complied with.

04.3020. The tests shall be supplemented by special tests or analyses to prove compliance with multiplying factor of safety requirements. (See CAR 04.27.)

04.3021. When a unit other than the specific one tested is incorporated in the airplane presented for certification, the results of *strength* tests shall be reduced to correspond to the minimum guaranteed mechanical properties of the materials specified on the drawings, unless test loads are carried at least 15 percent beyond the required values.

04.3022. The determination of test loads, the apparatus used and the methods of conducting the tests shall be satisfactory to the Secretary.

04.3023. The tests shall be conducted in the presence of a representative of the Bureau unless otherwise directed by the Secretary.

04.303. *Flight load tests.*—Proof of strength by means of flight load tests will not be accepted unless the necessity therefor is established and the test methods are proved suitable to the satisfaction of the Secretary.

04.304. *Load tests required.*—The following load tests are required in all cases and shall be made in the presence of a representative of the Bureau unless otherwise directed by the Secretary:

(a) Strength tests of wing ribs. (See CAR 04.313.)

(b) Pressure tests of fuel and oil tanks. (See CAR 04.623.)

(c) Proof tests of tail and control surfaces. (See CAR 04.32.)

(d) Proof and operating tests of control systems. (See CAR 04.33 and CAR 04.331.)

04.31. *Proof of wings.*—Proof of wings by structural analysis only shall be in accordance with CAR 04.300 except that the strength of stressed-skin wings shall be substantiated by load tests (CAR 04.302) or by combined structural analysis and tests (CAR 04.301).

04.310. *Redundancies.*—Wing cellules in which the division of loading between lift trusses and drag trusses is indeterminate shall be analyzed either by an acceptable method for indeterminate structures or by making assumptions which result in conservative design loads for all members.

04.311. *Beams.*—The following points shall be covered in the proof of strength of wing beams, in addition to any special types of possible failure peculiar to the structure.

04.3110. *Secondary bendings.*—When axial loads are present the required minimum *ultimate* factor of safety shall be introduced before the computation of the bending moments in order to insure that the required *ultimate* loads can be supported by the structure.

04.3111. *Lateral buckling.*—The ability of beams to resist lateral buckling shall be proved.

04.3112. *Webs.*—The strength of shear webs shall be proved.

04.3113. When axial load is present tests are required to determine the effective "EI" in the case of truss-type beams and beams having unconventional web construction.

04.3114. *Joint slippage in wood beams.*—When a joint in a wood beam is designed to transmit bending from one section of the beam to another or to the fuselage, the stresses in each part of the structure shall be calculated on the assumption that the joint is 100 per cent efficient (except in mid-bay for which see CAR 04.4110) and also under the assumption that the bending moment transmitted by the joint is 75 percent of that obtained under the assumption of perfect continuity. Each part of the structure shall be designed to carry the most severe loads determined from the above assumptions.

04.3115. *Bolt holes.*—In computing the area, moment of inertia, etc., of wood beams pierced by bolts, the diameter of the bolt hole shall be assumed to be one-sixteenth inch greater than the diameter of the bolt.

04.3116. In computing the ability of box beams to resist bending loads only that portion of the web with its grain



parallel to the beam axis and one-half of that portion of the web with its grain at an angle of 45° to the beam shall be considered. The more conservative method of neglecting the web entirely may be employed.

04.312. *Drag trusses.*—Drag struts shall be assumed to have an end fixity coefficient of 1.0 except in cases of unusually rigid restraint, in which a coefficient of 1.5 may be used.

04.313. *Ribs.*—Structural analysis of ribs, or their equivalent, is not acceptable as a satisfactory means of demonstrating their strength. Tests to at least 125% of the required *ultimate* load, and covering the most severe loading conditions for the ribs, are required. The following points shall apply in proving the strength of ribs.

04.3130. The load shall be suitably distributed between upper and lower wing surfaces unless a more severe distribution is used.

04.3131. The effects of ailerons and high-lift devices shall be properly accounted for.

04.3132. Rib tests shall simulate conditions in the airplane with respect to torsional rigidity of spars, fixity conditions, lateral support and attachment to spars.

04.314. *Covering.*—Proof of strength of fabric covering is not required when standard grades of cloth and methods of attaching and doping are employed provided, however, that the Secretary may require special tests when it appears necessary to account for the effects of unusually high design airspeeds or slipstream velocities, or similar factors. When metal covering is employed its ability to perform its structural function shall be demonstrated by tests of typical panels or by other means acceptable to the Secretary. In particular, compliance with CAR 04.201 requires demonstration of the behavior of the covering under load in order to determine the effects of temporary deformations (wrinkles).

04.315. *Non-parallel wires.*—When two or more wires are attached to a common point on the wing, but are not parallel, proper allowance for redundancies and the effects of rigging shall be made.

04.32. *Proof of tail and control surfaces.*—Structural analyses of tail and control surfaces will be accepted as complete proof of compliance with *ultimate* load requirements only when the structure conforms with conventional types for which reliable analytical methods are available. Proof tests as defined in CAR 04.127 are required to prove compliance with *yield* load requirements.

04.320. Control surface tests shall include the horn or fitting to which the control system is attached.

04.321. In the analysis of control surfaces proper allowance shall be made for rigging loads in brace wires in cases where the counter wires do not go slack before the *ultimate* load is reached.

04.322. Analyses or individual load tests shall be conducted to demonstrate compliance with the multiplying factor of safety requirements outlined in CAR 04.27 for control surface hinges and brace wires.

04.33. *Proof of control systems.*—Structural analyses of control systems will be accepted as complete proof of compliance with *ultimate* load requirements only when the structure conforms with conventional types for which reliable analytical methods are available. Proof tests as defined in CAR 04.127 are required to prove compliance with *yield* load requirements.

04.330. In control system tests, the direction of test loads shall be such as to produce the most severe loading of the control system structure. The tests shall include all fittings, pulleys and brackets used to attach the control system to the primary structure.

04.331. *Operation test.*—An operation test shall be conducted by operating the controls from the pilot's compartment with the entire system so loaded as to correspond to the minimum *limit* control force specified for the design of the control system. (See Table 04-6.) In this test there shall be no jamming, excessive friction or excessive deflection.

04.332. Analyses or individual load tests shall be conducted to demonstrate compliance with the multiplying factor of safety requirements specified in CAR 04.27 for control system joints subjected to angular motion.

04.34. *Proof of landing gear.*—Structural analyses of landing gear will be accepted as complete proof of compliance with load requirements only when the structure conforms with conventional types for which reliable analytical methods are available. Analyses may be used to demonstrate compliance with the energy absorption requirements in certain cases. When such analyses are not applicable, dynamic tests shall be conducted to demonstrate compliance with energy absorption requirements.

04.340. *Energy absorption tests.*—When tests for energy absorption are required they shall be so conducted as to simulate the landing conditions for which energy absorption requirements are specified in CAR 04.440, and test data shall be obtained from which the maximum acceleration developed at the center of gravity of the airplane can be determined. When drop tests of wheels, tires and shock absorbers are conducted in a combination differing from that employed on the airplane, proper allowance and corrections shall be made for the errors thus introduced.

04.35. *Proof of hulls and floats.*—Structural analyses of hulls and auxiliary floats will be accepted as complete proof of compliance with load requirements only when the structure conforms with conventional types for which reliable analytical methods are available. The strength of the structure as a whole and its ability to distribute water loads from the bottom plating into the main structural members shall be demonstrated. See CAR 15 for the requirements for main floats.

04.36. *Proof of fuselages and engine mounts.*—Structural analyses of fuselages and engine mounts will be accepted as complete proof of compliance with load requirements only when the structure conforms with conventional types for which reliable analytical methods are available.

04.360. The end fixity coefficient used in determining critical column loads shall in no case exceed 2.0. A value of 1.0 shall be used for all members in the engine mount. In doubtful cases, tests are required to substantiate the degree of restraint assumed.

04.361. *Baggage compartments.*—The ability of baggage compartments to sustain the maximum authorized baggage loads under all required flight and landing conditions shall be demonstrated.

04.37. *Proof of fittings and parts.*—Proof of strength of all fittings and joints of the primary structure is required. Where applicable, structural analysis methods may be used. When such methods are inadequate, a load test is required. Compliance with the multiplying factor of safety requirements for fittings (CAR 04.27) shall be demonstrated.

04.370. Since the system of forces which designs a fitting does not necessarily include the forces which design the attaching members, all the forces acting in all the specified conditions shall be considered for every fitting. The strength of each part of a built-up fitting shall be investigated and proper allowance shall be made for the effects of eccentric loading when initially present or when introduced by deflection of the structure under load.

04.371. *Bolts.*—The allowable bearing load assumed for the threaded portion of a bolt shall not exceed 25 per cent of the rated shear strength of the bolt.

04.4. *Detail design and construction.*—

04.40. *General.*—The primary structure and all mechanisms essential to the safe operation of the airplane shall not incorporate design details which experience has shown to be unreliable or otherwise unsatisfactory. The suitability of all design details shall be established to the satisfaction of the Secretary. Certain design features which have been found to be essential to the airworthiness of an airplane are hereinafter specified and shall be observed.

04.400. *Materials and workmanship.*—The primary structure shall be made from materials which experience or conclusive tests have proved to be uniform in quality and



strength and to be otherwise suitable for airplane construction. Workmanship shall be of sufficiently high grade as to insure proper continued functioning of all parts.

04.401. *Fabrication methods.*—The methods of fabrication employed in constructing the primary structure shall be such as to produce a uniformly sound structure which shall also be reliable with respect to maintenance of the original strength under reasonable service conditions.

04.4010. *Gluing.*—Gluing may be used except in cases where inferior joints might result or where proper protection from moisture cannot be shown.

04.4011. *Torch welding.*—Torch welding of primary structural parts may be used only for ferrous materials and for such other materials shown to be suitable therefor.

04.4012. *Electric welding.*—Electric arc, spot or seam welding may be used in the primary structure when specifically approved by the Secretary for the application involved. Requests for approval of the use of electric welding shall be accompanied by information as to the extent to which such welding is to be used, drawings of the parts involved, apparatus employed, general methods of control and inspection, and references to test data substantiating the strength and suitability of the welds obtained.

04.4013. *Brazing and soldering.*—The use of brazing and soldering in joining parts of the primary structure is prohibited except that brazing may be used in special cases when the suitability of the method and application can be definitely established to the satisfaction of the Secretary.

04.4014. *Protection.*—All members of the primary structure shall be suitably protected against deterioration or loss of strength in service due to corrosion, abrasion, vibration or other causes. This applies particularly to design details and small parts. In seaplanes special precautions shall be taken against corrosion from salt water, particularly where parts made from different metals are in close proximity. All exposed wood structural members shall be given at least two protective coatings of varnish or approved equivalent. Built-up box spars and similar structures shall be protected on the interior by at least one coat of varnish or approved equivalent and adequate provisions for drainage shall be made. Due care shall be taken to prevent coating of the gluing surfaces.

04.4015. *Inspection.*—Inspection openings of adequate size shall be provided for such vital parts of the aircraft as require periodic inspection.

04.402. *Joints, fittings and connecting parts.*—In each joint of the primary structure the design details shall be such as to minimize the possibility of loosening of the joint in service, progressive failure due to stress concentration, and damage caused by normal servicing and field operations. (See CAR 04.271 for multiplying factors of safety required.)

04.4020. *Bolts, pins and screws.*—All bolts and screws in the structure shall be of uniform material of high quality and of first-class workmanship. Machine screws shall not be used in the primary structure unless specifically approved for such use by the Secretary. The use of an approved locking device or method is required for all bolts, pins and screws.

04.4021. *Wood screws.*—The use of wood screws in the primary structure is prohibited except in special cases when the suitability of the particular application is proved to the satisfaction of the Secretary.

04.4022. *Eyebolts.*—Special eyebolts and similar special bolts shall have a fillet between the head and the shank of at least  $\frac{1}{4}$  the diameter of the bolt when used in control surfaces or at other locations where they might be subjected to bending or vibration.

04.4023. *Castings.*—Castings used in the primary structure shall incorporate the multiplying factor of safety specified in CAR 04.272 and shall be of such material and design as to insure the maximum degree of reliability and freedom from defects. The Secretary reserves the right to prohibit the use of castings where such use is deemed to be unairworthy.

04.403. *Tie-rods and wires.*—The minimum size of tie-rod which may be used in primary structure is No. 6-40. The corresponding minimum allowable size of single-strand hard wire is No. 13 (0.072-inch diameter).

04.4030. *Wire terminals.*—The assumed terminal efficiency of single-strand hard wire shall not be greater than 85 per cent.

04.4031. *Wire anchorages.*—A fitting attached to a wire or cable up to and including the 3,400-pound size shall have at least the rated strength of the wire or cable, and the multiplying factor of safety for fittings (CAR 04.271) is not required in such cases. In the case of fittings to which several tie-rods or wires are attached, this requirement applies separately to each portion of the fitting to which a tie-rod or wire is attached, but does not require simultaneous application of rated wire loads. The end connections of brace wires shall be such as to minimize restraint against bending or vibration.

04.4032. *Counter wire sizes.*—(See also CAR 04.274 and 04.275.) In a wire-braced structure the wire sizes shall be such that any wire can be rigged to at least 10 per cent of its rated strength without causing any other wire to be loaded to more than 20 per cent of its rated strength. As used here "rated strength" refers to the wire proper, not the terminal.

04.404. *General flutter prevention measures.*—The Secretary reserves the right to require special provisions against flutter in any case when such provisions appear to him to be necessary.

04.4040. *Vibration tests.*—Experimental determination of the natural frequency of vibration of certain components of the airplane is required in cases when there are indications of dangerously low frequencies or of coincidence of the natural frequencies of two or more separate structural components.

04.41. *Detail design of wings.*—

04.410. *External bracing.*—When streamline wires are used for external lift bracing they shall be double unless the design complies with the lift-wire-cut condition specified in CAR 04.2161. (See also CAR 04.273.)

04.4100. *Wire-braced monoplanes.*—If monoplane wings are externally braced by wires only, the right and left sides of the bracing shall be independent of each other so that an unsymmetrical load from one side will not be carried through the opposite wires before being counteracted, unless the design complies with the following conditions:

(a) The minimum true angle between any external brace wire and a spar is  $14^{\circ}$ .

(b) The counter (landing) wires are designed to remain in tension at least up to the limit load.

(c) The landing and flying wires are double.

04.4101. Multiple-strand cable shall not be used in lift trusses.

04.4102. *Jury struts.*—Clamps shall not be used for the attachment of jury struts.

04.411. *Wing beams.*—Provisions shall be made to reinforce wing beams against torsional failure, especially at the point of attachment of lift struts, brace wires and aileron hinge brackets.

04.4110. *Wing beam joints.*—Joints in metal beams (except pinned joints) and joints in mid-bays of wood beams shall maintain 100 per cent efficiency of the beam with respect to bending, shear and torsion.

04.412. *Drag truss.*—Fabric-covered wing structures having a cantilever length or overhang such that the ratio of span of overhang to chord at root of overhang is greater than 1.75 shall have a double system of internal drag trussing spaced as far apart as possible, or other means of providing equivalent torsional stiffness. In the former case counter wires shall be of the same size as the drag wires. (See also CAR 04.275.)

04.4120. Multiple-strand cable shall not be used in drag trusses unless such use is substantiated to the satisfaction of the Secretary.



04.413. *Aileron and flap attachments.*—Aileron and flap attachment ribs or brackets shall be rigidly constructed and firmly attached to the main wing structure in order to reduce wing flutter tendencies.

04.414. *Internally-braced biplanes.*—Internally-braced biplanes shall be provided with N or I struts to equalize deflections, and the effect of such struts shall be considered in the stress analysis.

04.415. *Fabric covering.*—Fabric covering shall comply with the requirements of CAR 04.400 and shall be attached in a manner which will develop the necessary strength, with due consideration for slip-stream effects. (See CAR 04.314.)

04.416. *Metal-covered wings.*—The detail design of such wings shall incorporate suitable provision against buckling or wrinkling of metal covering as specified in CAR 04.201 and 04.314.

04.417. *Lift truss system.*—All structural members in the wing lift truss system which transmit direct loads from the landing gear shall be overstrength with respect to landing loads, so as to reduce the probability of damaging the wing in severe landings. This will require that, for any given landing condition, the minimum margin of safety in the lift truss structure shall be greater than the minimum margin of safety in the landing gear structure for the same condition.

04.42. *Detail design of tail and control surfaces.*—

04.420. *Installation.*—Movable tail surfaces shall be so installed that there is no interference between the surfaces or their bracing when any one is held in its extreme position and any other is operated through its full angular movement.

04.421. *Stops.*—When an adjustable stabilizer is used, stops shall be provided at the stabilizer to limit its movement, in the event of failure of the adjusting mechanism, to a range equal to the maximum required to balance the airplane. (See also CAR 40.4261.)

04.422. *Hinges.*—Hinges of the strap type bearing directly on torque tubes are permissible only in the case of steel torque tubes which have a multiplying factor of safety as specified in CAR 04.276. In other cases sleeves of suitable material shall be provided for bearing surfaces.

04.4220. Clevis pins may be used as hinge pins provided that they are made of material conforming with, or the equivalent of, S. A. E. Specification 2330.

04.423. *Elevators.*—When separate elevators are used they shall be rigidly interconnected.

04.424. *Ailerons.*—Ailerons attached to internally-braced wings, to wings braced by wires only or to wings which in the opinion of the Secretary are susceptible to flutter, shall be statically balanced about their hinge lines when in the neutral position. A special ruling shall be obtained from the Secretary when such balance is obtained by means of a single balance weight for each aileron, or when the aileron control system is irreversible.

04.425. *Wing flaps.*—Flaps shall be so installed as not to induce flutter or appreciable buffeting.

04.426. *Tabs.*—Control surface trailing-edge tabs shall be statically balanced about their hinge lines unless and irreversible non-flexible tab control system is used. The installation shall be such as to prevent development of any free motion of the tab.

04.4260. When trailing-edge tabs are used to assist in moving the main surface (balancing tabs), care shall be taken in proportioning areas and relative movements so that the main surface is not aerodynamically overbalanced at any time.

04.4261. Elevator trailing-edge tab systems shall be equipped with stops which limit the travel of the tab to the angular values provided for in the structural report. The range of tab movement shall be sufficient to result in a speed of not more than 90 miles per hour in a glide with power off, under the loading condition of most forward center of gravity certified.

04.427. *Tail surface balancing.*—In the case of airplanes having a high speed in level flight greater than 150 miles per hour, the dynamic balance coefficient of the rudder and of each separate elevator as computed about the point of intersection of the hinge line with the center line of the fuselage shall be not more than 0.08. This coefficient is non-dimensional and consists of a fraction whose numerator is the resultant weight product of inertia of the control surface and whose denominator is equal to the weight multiplied by the aerodynamic area of the control surface. The resultant product of inertia is obtained from the algebraic sum of the products of inertia in the four quadrants, considering the products of inertia in the first and third quadrants as positive and those in the second and fourth quadrants as negative. If the rudder is completely mass-balanced the requirements for elevators may be modified upon application to the Secretary.

04.43. *Detail design of control systems.*—

04.430. *Installation.*—Proper precautions shall be taken with respect to control systems to eliminate the possibility of jamming, interference from cargo, passengers or loose objects, and chafing or slapping of cables against parts of the airplane. All pulleys shall be provided with satisfactory guards. A control column or stick located between a pilot and a passenger shall not be used unless a throw-over type of wheel control is incorporated.

04.431. *Stops.*—All control systems shall be provided with stops which positively limit the range of motion of the control surfaces. Stops shall be capable of withstanding the loads corresponding to the design conditions for the control system.

04.432. *Joints.*—Bolts with castellated nuts safetied with cotter pins or with an approved type of self-locking nut shall be used throughout the control system, except that the use of clevis pins in standard cable ends, thimbles and shackles is satisfactory for light airplanes as defined in CAR 04.01.

04.433. *Welds.*—Welds shall not be employed in control systems to carry tension without reinforcement from rivets or bolts.

04.434. *Flap controls.*—The flap operating mechanism shall be such as to prevent sudden, inadvertent or automatic opening of the flap at speeds above the design speed for the extended flap conditions. The time required to fully extend or retract flaps shall not be less than 15 seconds, unless it can be demonstrated to the satisfaction of the Secretary that the operation of the flaps in a lesser time does not result in unsatisfactory flight characteristics. Means shall be provided to retain flaps in their fully retracted position and to indicate such position to the pilot.

04.435. *Tab controls.*—Tab controls shall be irreversible and non-flexible, unless the tab is statically balanced about its hinge line. Proper precautions shall be taken against the possibility of inadvertent or abrupt tab operation and operation in the wrong direction.

04.4350. When adjustable elevator tabs are used for the purpose of trimming the airplane, a tab position indicator shall be installed and means shall be provided for indicating to the pilot a range of adjustment suitable for safe take-off and the directions of motion of the control for nose-up and nose-down motions of the airplane.

04.436. *Spring devices.*—The use of springs in the control system either as a return mechanism or as an auxiliary mechanism for assisting the pilot (bungee device) is prohibited except under the following conditions:

(a) The airplane shall be satisfactorily maneuverable and controllable and free from flutter under all conditions with and without the use of spring device.

(b) In all cases the spring mechanism shall be of a type and design satisfactory to the Secretary.

(c) Rubber cord shall not be used for this purpose.

04.437. *Single-cable controls.*—Single-cable controls are prohibited except in special cases in which their use can be proved to be satisfactory.



04.438. *Control system locks.*—When a device is provided for locking the control surfaces in position while the aircraft is on the ground or water, the following provisions shall apply:

(a) The locking device shall be so installed that it can be completely released from all controls with ease and rapidity by a person sitting in either pilot's seat.

(b) For landplanes the device shall be so installed that, until released to provide full manipulation of all controls, it presents a definite obstruction to taxiing the aircraft or starting a take-off. This shall be accomplished by locking the throttle control or by some equally effective measure. For seaplanes the device may, if desired, be so installed as to permit maneuvering on the water with the controls locked, but in any event the means of locking shall definitely prevent the seaplane from being taken into the air.

04.44. *Detail design of landing gear.*—

04.440. *Shock absorption.*—All landing gear (including tail gear installations) shall be provided with shock-absorbing systems which will permit the airplane to be landed under the conditions specified in CAR 04.2411 and CAR 04.2420 without exceeding the ultimate load used in the analysis of any landing gear member. (See CAR 04.340 for proof of absorption capacity.) If the design of the shock-absorbing system is such that the above method of specifying the required energy absorption capacity appears to give irrational results, an alternate method will be considered upon presentation of pertinent data.

04.441. *Shock-absorbing systems.*—The shock-absorbing systems employed shall incorporate suitable means for absorbing the shocks developed in taxiing or running over rough ground.

04.442. *Wheels.*—Main landing gear wheels shall be of a type or model certificated by the Secretary in accordance with the provisions of CAR 15 and shall not be subjected to static loads in excess of those for which they are certificated. Tail wheels may be of any type or model and are not certificated. Nose wheels are subject to special rulings to be made by the Secretary.

04.4420. For the purpose of these regulations main landing gear wheels are considered as those nearest the airplane center of gravity with respect to fore-and-aft location.

04.4421. For the purpose of these regulations a tail wheel is considered as one which supports the tail of a conventional airplane in the three-point landing attitude. A nose wheel is considered to be a wheel supporting the nose of the airplane when the two main wheels are located behind the center of gravity.

04.443. *Tires.*—A landing gear wheel may be equipped with any make or type of tire, provided that the tire is a proper fit on the rim of the wheel and provided that the tire manufacturer's recommended load rating is not exceeded.

04.4430. When specially constructed tires are used to support an airplane, the wheels shall be plainly and conspicuously marked to that effect. Such markings shall include the make, size, number of plies and identification marking of the proper tire.

04.444. *Retracting mechanism.*—When retractable landing wheels are used, visual means shall be provided for indicating to the pilot, at all times, the position of the wheels. Separate indicators for each side are required when each side is separately operated unless a single indicator is obviously satisfactory. In addition, an aural or other equally effective indicator shall be provided and shall function continuously after the throttle is closed until the gear is down and locked.

04.4440. A positive lock shall be provided for the wheels in the extended position, unless a rugged irreversible mechanism is used.

04.4441. Manual operation of retractable landing gears shall be provided for.

04.45. *Hulls and floats.*—(See also CAR 04.46.)

04.450. *Buoyancy (main seaplane floats).*—Main seaplane floats shall have a buoyancy in excess of that required to support the gross weight of the airplane in fresh water as follows:

- (a) 80 per cent in the case of single floats,
- (b) 90 per cent in the case of double floats.

04.4500. Main seaplane floats for use on aircraft of 2500 pounds or more maximum authorized weight shall contain at least five water-tight compartments of approximately equal volume. Main seaplane floats for use on aircraft of less than 2500 pounds maximum authorized weight shall contain at least four such compartments.

04.451. *Buoyancy (boat seaplanes).*—The hulls of boat seaplanes and amphibians shall be divided into water-tight compartments in accordance with the following requirements:

(a) In aircraft of 5,000 pounds maximum authorized weight or more the compartments shall be so arranged that, with any two adjacent compartments flooded, the hull and auxiliary floats (and tires, if used) will retain sufficient buoyancy to support the gross weight of the aircraft in fresh water.

(b) In aircraft of 1,500 to 5,000 pounds maximum authorized weight the compartments shall be so arranged that, with any one compartment flooded, the hull and auxiliary floats (and tires, if used) will retain sufficient buoyancy to support the maximum authorized weight of the aircraft in fresh water.

(c) In aircraft of less than 1,500 pounds maximum authorized weight water-tight subdivision of the hull is not required.

(d) Bulkheads may have water-tight doors for the purpose of communication between compartments.

04.452. *Water stability.*—Auxiliary floats shall be so arranged that when completely submerged in fresh water, they will provide a righting moment which is at least 1.5 times the upsetting moment caused by the aircraft being tilted. A greater degree of stability may be required in the case of large flying boats, depending on the height of the center of gravity above the water level, the area and location of wings and tail surfaces, and other considerations.

04.453. *Float design.*—In designing the bow portion of floats and hulls suitable provision shall be made for the effects of striking floating objects.

04.46. *Fuselage and cabins.*—

04.460. *Provision for turn-over.*—The fuselage and cabins shall be designed to protect the passengers and crew in the event of a complete turn-over and adequate provision shall be made to permit egress of passengers and crew in such event. This requirement may be suitably modified when the possibility of a complete turn-over in landing is remote. (See also CAR 04.247 for loading requirements.)

04.461. *Doors.*—Closed cabins on all aircraft carrying passengers shall be provided with at least one adequate and easily accessible external door.

04.4610. No passenger door shall be located in the plane of rotation of a propeller, nor within 5° thereof as measured from the propeller hub.

04.4611. The passenger door on landplanes certificated for airline service shall be located on the left-hand side of the cabin.

04.462. *Exits.*—Closed cabins on aircraft carrying more than 5 passengers shall be provided with emergency exits, in addition to the one external door required by CAR 04.461, consisting of movable windows or panels or of additional external doors which provide a clear and unobstructed opening, the minimum dimensions of which shall be 19 inches by 26 inches if elliptical or rectangular, or 26 inches in diameter if circular. The location and the method of operation of emergency exits shall be approved by the Secretary. If the pilot is in a compartment separate from the cabin, passage



through such compartment shall not be considered as an emergency exit for the passengers. The number of emergency exits required is as follows:

(a) Aircraft with a total seating capacity of more than 5 persons, but not in excess of 15, shall be provided with at least one emergency exit or one suitable door in addition to the main door specified in CAR 04.461. This emergency exit, or second door, shall be on the opposite side of the cabin from the main door. If desired, an additional emergency exit may be provided in the top of the cabin, but such an installation shall not obviate the necessity for an exit on each side.

(b) Aircraft with a seating capacity of more than 15 persons shall be provided with an additional emergency exit or door either in the top or side of the cabin for every additional 7 persons or fraction thereof above 15, except that not more than 4 exits, including doors, will be required if the arrangement and dimensions are suitable for the purpose intended.

04.463. *Pilot's compartment.*—The pilot's compartment shall be so constructed as to afford suitable ventilation and adequate vision to the pilot under normal flying conditions. In cabin aircraft the windows shall be so arranged that they may be readily cleaned or easily opened in flight to provide forward vision for the pilot. The ventilation requirements of CAR 04.467 shall also apply to the pilot's compartment.

04.4630. The pilot and the primary control units, including cables and control rods, shall be so located with respect to the propellers that no portion of the pilot or controls lies in the region between the plane of rotation of any propeller and the surface generated by a line passing through the center of the propeller hub and making an angle of 5° forward or aft of the plane of rotation of the propeller.

04.4631. A metal identification plate shall be permanently affixed in a visible location in the pilot's compartment of each airplane. This plate shall contain the manufacturer's name, the date of manufacture, the manufacturer's serial number and the model designation. The manufacturer shall specify the fuel capacity of each fuel tank on the manufacturer's identification plate, or on or adjacent to the fuel shut-off valves in the pilot's compartment.

04.4632. There shall be placed, in full view of the pilot, such placards as are required in CAR 04.74 (operation limitations) and in CAR 04.723 (emergency ceiling).

04.4633. The windows and windshields of the pilot's compartment in airplanes certificated for airline service shall be so arranged as to provide satisfactory forward vision and protection under all conditions and, to accomplish this, particular attention shall be paid to the following detail requirements:

(a) The windshield shall be constructed of high grade glass at least  $\frac{3}{8}$  inch thick and having at least 5 lamination held together with a strong binder, except that a substitute therefor is permissible provided that it has equivalent strength and satisfactory optical properties. The structure supporting the windshield shall be of equivalent strength.

(b) Windshields shall be so installed that they can be easily opened in flight and shall be so arranged that the air stream and snow or rain are deflected across the opening, or to provide equivalent results.

(c) The pilot's compartment shall be so constructed and arranged as to prevent glare or reflections which would interfere with the vision of either pilot, particularly while flying at night. The aircraft shall be flown by a Bureau representative during hours of darkness to determine compliance with this provision.

04.4634. The pilot's compartment in airplanes certificated for airline service shall be so constructed as to prevent any leakage into it when the airplane is flying in rain or snow.

04.4635. Two seats shall be installed side-by-side in the pilot's compartment of airplanes certificated for airline serv-

ice from either of which the airplane shall be fully and readily controllable. If any difference exists as to convenience of the instruments and controls necessary for safe flight such difference should favor the left-hand seat. The left-hand seat shall be known as the first pilot's seat and the right-hand one as the second pilot's seat.

04.4636. The navigation instruments for use by the pilot in airplanes certificated for airline service shall be so installed as to be easily visible to him with the minimum practicable deviation from his normal position and line of vision when he is looking out and forward along the flight path and they shall also be visible to the second pilot.

04.4637. All airplanes certificated for airline service shall be provided with a door or an adequate openable window between the pilot's compartment and the passengers' cabin, which shall be so arranged as to permit direct oral communication between either pilot and the passengers. When a door is provided it shall be equipped with a locking means which shall prevent passengers from opening such door while in flight.

04.464. *Passenger chairs.*—Seats or chairs for passengers shall be securely fastened in place in both open and closed airplanes, whether or not the safety belt load is transmitted through the seat. (See CAR 15 and CAR 04.2640 for safety belt requirements.)

04.465. *Baggage compartments.*—Each baggage and mail compartment shall bear a placard stating the maximum allowable weight of contents, as determined by the structural strength of the compartment (CAR 04.265) and by flight test (CAR 04.742). Suitable means shall be provided to prevent the contents of mail and baggage compartments from shifting.

04.466. *Reinforcement near propellers.*—Surfaces near propeller tips shall be suitably stiffened against vibration and the effects of ice thrown from the propeller. (See CAR 04.611 for clearance requirements.)

04.467. *Passenger compartments.*—A suitable ventilation system shall be provided which will preclude the presence of fuel fumes and dangerous traces of carbon monoxide in each passenger compartment.

#### 04.5. *Equipment.*—

04.50. *General.*—The equipment required shall be dependent upon the type of operation for which certification is to be made. The requirements specified herein (CAR 04.5) shall be the basic equipment requirements and such additional equipment as may be specified in other sections of the Civil Air Regulations for specific special cases shall be supplemental hereto unless otherwise specified.

04.500. Each item of equipment specified in the Civil Air Regulations shall be of a type and design satisfactory to the Secretary, shall be properly installed and shall function to the satisfaction of the Secretary. Items of equipment for which certification is required shall have been certificated in accordance with the provisions of CAR 15 or previous regulations.

04.501. An approved life preserver or flotation device is one approved by the Secretary for such usage on sea-going vessels.

04.502. Fire extinguishing apparatus approved by the Underwriters Laboratories is considered to be of an approved type.

04.503. Approved radio equipment is such as has been approved by the Secretary as complying with the current issue of "Specifications for the Approval of Airline Aircraft Radio Equipment".

04.51. *Non-Airline carrier (NAC) airplanes.*—Airplanes which are certificated as non-airline carriers, shall have at least the following equipment:

04.510. *NAC landplanes—Visual-Contact Day Flying (Within 100 Miles of a Fixed Base).*—

(a) One airspeed indicator. (See CAR 04.5800 for installation requirements.)

(b) One altimeter.



(c) A tachometer for each engine.  
 (d) An oil-pressure gauge when an oil-pressure system is employed.

(e) A water thermometer for each water-cooled engine.

(f) An oil thermometer for each air-cooled engine.

(g) A manifold-pressure gauge, or equivalent, for each altitude engine. (See CAR 13.)

(h) A fuel quantity gauge. (See CAR 04.624 for requirements.)

(i) Certificated safety belts for all passengers and members of the crew. (See CAR 15 for belt requirements and CAR 04.5810 for installation requirements.)

(j) A portable fire extinguisher in cabin airplanes, which extinguisher shall be of an approved type which shall have a minimum capacity, if carbon tetrachloride, of one quart or, if carbon dioxide, of two pounds or, if other, of equivalent effectiveness; except that any extinguisher of not less than half the above capacity may be used in an airplane equipped with an engine whose maximum rating is 40 horsepower or less. (See CAR 04.5811 for installation requirements.)

(k) Landing gear position indicator for retractable main landing gear. (See CAR 04.444 for requirements.)

(l) A device for measuring or indicating the amount of oil in the tanks. (See CAR 04.633 for requirements.)

(m) A first aid kit, in airplanes arranged for carrying passengers.

(n) A log-book for the airplane and one for each engine. (See CAR 01 for requirements.)

(o) Rigging information for airplanes with wire-braced wings, either in the form of a sketch or listed data, which shall include sufficient information to permit proper rigging.

**04.511. NAC landplanes—Visual-contact day flying (unlimited distance).**—Airplanes of this category shall have the equipment specified in CAR 04.510 and, in addition, there shall be installed:

(a) A magnetic compass. (See CAR 04.5803 for installation requirements.)

**04.512. NAC landplanes.—Visual-contact night flying.**—Airplanes of this category shall have the equipment specified in CAR 04.511 and, in addition, there shall be installed:

(a) A set of certified standard forward position lights in combination with a certificated tail light. (See CAR 15 for light requirements and CAR 04.5827 for installation requirements.)

(b) Two electric landing lights, if the aircraft is operated for hire. (See CAR 04.5825 for installation requirements.)

(c) Certificated landing flares, if the aircraft is operated for hire, as follows (See CAR 15 for flare requirements and CAR 04.5813 for installation requirements):

Airplanes of 3500 pounds maximum authorized weight or less—5 Class 3 flares or 3 Class 2 flares.

Airplanes of between 3500 pounds and 5000 pounds maximum authorized weight—4 Class 2 flares.

Airplanes of 5000 pounds maximum authorized weight or more—2 Class 1 flares or 3 Class 2 flares and one Class 1 flare.

If desired, airplanes of less than 5000 pounds maximum authorized weight may carry the flare equipment specified for heavier airplanes.

(d) A storage battery suitable as a source of energy supply for the lights installed. (See CAR 04.5821 for installation requirements.)

(e) Radio equipment, if the aircraft is operated for hire, as follows: A radio beacon and weather broadcast receiver operating within the frequency range of 200 to 400 kilocycles. Under normal atmospheric conditions this receiver must be capable of receiving with a range of 100 miles intelligence emanated from a radio range or weather broadcast station the equivalent of an SBRA installation.

(f) A set of spare fuses. (See CAR 04.5822 for installation requirements.)

**04.513. NAC landplanes—instrument day flying.**—Airplanes of this category shall have the equipment specified in CAR 04.511 and, in addition, there shall be installed:

(a) *Radio equipment.*—Same as CAR 04.512 (e), whether the aircraft is operated for hire or not, and, in addition, a radio transmitter operated on 3105 kilocycles with a power output sufficient to establish communication at a distance of at least 100 miles under normal atmospheric conditions. Additional frequencies may be employed subject to approval of the Federal Communications Commission.

(b) A gyroscopic rate-of-turn indicator.

(c) A bank indicator. (Instruments (b) and (c) may be combined in one instrument if desired or may be omitted if a gyroscopic artificial horizon instrument is installed.)

(d) A sensitive altimeter which shall be adjustable for changes in barometric pressure and compensated for changes in temperature.

(e) A clock with a sweep-second hand.

(f) A storage battery suitable as a source of energy supply for the radio equipment installed. (See CAR 04.5821 for installation requirements.)

(g) A generator.

(h) A set of spare fuses. (See CAR 04.5822 for installation requirements.)

**04.514. NAC landplanes—Instrument night flying.**—Airplanes of this category shall have the equipment specified in CAR 04.512 and CAR 04.513 combined. The storage battery shall be suitable as a source of energy supply for both the radio equipment and the lights.

**04.515. NAC seaplanes and amphibians.**—The equipment requirements for seaplanes and amphibians shall be the same as specified for landplanes (CAR 04.510 through 04.514) except that seaplanes and amphibians shall not be certificated for operation over water out of sight of land unless they have at least the equipment specified in CAR 04.511, and except that all certificated seaplanes and amphibians shall also have an approved life preserver or flotation device for each person for which there is a seat, and except that all seaplanes and amphibians certificated for night operation shall also have a white anchor light. (See CAR 04.5824 for installation requirements.)

**04.52. Airline carriers—goods (ACG).**—(To be supplied.)

**04.53. Airline carriers—passengers (ACP).**—Airplanes certificated for use as airline passenger carriers shall have installed at least the following equipment:

**04.530. ACP landplanes—visual-contact day flying.**—The same as specified in CAR 04.511 and, in addition, the following:

(a) An electrically heated pitot tube, or equivalent, for the air speed indicator.

(b) One additional portable fire extinguisher of the type specified in CAR 04.510 (j). (See CAR 04.5811 for installation requirements.)

(c) Fixed fire extinguishing apparatus of an approved type for each engine compartment.

(d) Safety belt sign or signal. (See CAR 04.5812 for installation requirements.)

(e) Radio equipment as follows: An approved two-way radio system consisting of a transmitter and receiver capable of operating on the frequency or frequencies specified by the Federal Communications Commission and independent of any facility provided by the Federal Government. In addition an approved beacon and weather broadcast receiver is required. The question of power and/or range of this equipment will be determined by the Secretary upon application for a Letter of Authority to operate a scheduled service.

(f) A set of spare fuses. (See CAR 04.5822 for installation requirements.)



04.531. *ACP landplanes—visual-contact night flying.*—The same as specified in CAR 04.530 and, in addition, the following:

- (a) A set of certificated airline forward position lights or, alternatively, a combination consisting of a set of certificated standard forward position lights and a set of certificated auxiliary position lights. In any case a certificated tail light shall also be installed. (See CAR 15 for light requirements and CAR 04.5827 for installation requirements.)
- (b) A storage battery of sufficient capacity for all lights installed. (See CAR 04.5821 for installation requirements and CAR 04.5823.)
- (c) Two electric landing lights. (See CAR 04.5825 for installation requirements.)
- (d) Certificated landing flares as follows: 2 Class 1 flares or 3 Class 2 flares and 1 Class 1 flare. (See CAR 15 for flare requirements and CAR 04.5813 for installation requirements.)
- (e) Instrument lights. (See CAR 04.5826 for installation requirements.)
- (f) Cabin lights in all passenger cabins and compartments.
- (g) A generator. (See CAR 04.5823 for requirements.)
- (h) Radio equipment same as CAR 04.530 (e).

04.532. *ACP landplanes—instrument day flying.*—The same as specified in CAR 04.530 except 04.510 (b) and, in addition, the following:

- (a) A gyroscopic rate-of-turn indicator combined with a bank indicator.
- (b) A gyroscopic instrument showing bank and pitch.
- (c) A gyroscopic compass.
- (d) A rate-of-climb indicator.
- (e) Two sensitive-type altimeters, both of which shall be adjustable for changes in barometric pressure and compensated for changes in temperature.
- (f) A free air thermometer of the distance type with an indicating dial in the cockpit.
- (g) A clock with a sweep-second hand.
- (h) A vacuum gauge, installed in the lines leading to instruments (a), (b) and (c).

(i) Radio equipment as follows: Same as CAR 04.530 (e) and, in addition, an *approved* auxiliary beacon and weather broadcast receiver capable of receiving radio range signals and emergency broadcast. Such receiver system is normally operated from the main source of electrical supply of the aircraft but in the event of failure of the normal power source may be switched to operate from an independent power supply. This system shall include an independent power supply capable of operating such auxiliary receiver continuously for a period of at least four hours. It is also required that this emergency receiver operate from an independent antenna. Two sets of head-phones shall be required in the aircraft at all times. Effective January 1, 1938, there shall also be installed in such aircraft an *approved* radio direction finder, covering at least the frequency range of 200 to 400 kilocycles. The design of the radio direction finder shall be such as to permit its regular operation in the taking of line bearings on any station to which the direction finder may be tuned without altering the course of the aircraft. The radio direction finder shall also be provided with means to eliminate, insofar as possible, consistent with the advancement of the art, that type of interference commonly known as rain, snow, sleet or dust static. The radio direction finder shall provide means for audible reception of radio range and weather broadcast messages. This radio direction finder may be installed in lieu of the emergency receiver described herein provided that an independent power source equal to that described for the emergency receiver is employed on either the beacon receiver required under CAR 40.235 or on this radio direc-

tion finder. Effective November 1, 1937, there shall be installed on such aircraft an *approved* radio antenna system, which has for its purpose the collection of radio range signals, weather broadcast and emergency messages transmitted within the frequency range of 200 to 400 kcs. The design of this antenna system shall be such as to eliminate insofar as possible, consistent with the advancement of the art, that type of interference commonly known as rain, snow, sleet or dust static. This antenna system shall be so designed that it will operate efficiently when used in conjunction with a receiver installed aboard such aircraft which has for its primary purpose the reception of radio range signals, weather broadcast and emergency messages.

(j) A deicing signal to indicate icing conditions in the carburetor if the deicing device specified in CAR 04.6291 requires the manipulation of controls.

(k) A storage battery suitable as a source of energy supply for the radio equipment installed. (See CAR 04.5821 for installation requirements.)

(l) A generator.—(See CAR 04.5823 for installation requirements.)

04.533. *ACP landplanes—Instrument night flying.*—The same as specified in CAR 04.531 and CAR 04.532 combined. The storage battery, in this case, shall be of sufficient capacity for all radio equipment and all lights installed.

04.534. *ACP seaplanes and amphibians.*—The same as specified for landplanes (CAR 04.530 through CAR 04.533) and including the life preservers specified in CAR 04.515, except that when certificated for night operation, they shall also have installed the anchor light specified in CAR 04.515.

04.54. (Unassigned.)

04.55. (Unassigned.)

04.56. (Unassigned.)

04.57. (Unassigned.)

04.58. *Installation requirements.*—The following regulations apply to the installation of specific items of equipment and are additional to the regulations of CAR 04.50.

04.580. *Instruments.*—The following regulations shall apply to the installation of instruments when such instruments are required by these regulations.

04.5800. *Air speed indicator.*—This instrument shall be so installed as to indicate true air speed at sea level with the maximum practicable accuracy but in no event shall the instrument error be more than plus or minus 5 miles per hour at approximately 0.9 V<sub>L</sub>. (See CAR 04.111.)

04.5801. *Powerplant instruments and controls.*—(See CAR 04.650 and 04.651.)

04.5802. *Fuel quantity gauge.*—(See CAR 04.624.)

04.5803. *Magnetic compass.*—This instrument shall be properly damped and compensated and shall be located where it is least affected by electrical disturbances and magnetic influences.

04.5804. *Navigation instruments.*—Navigation instruments for use by the pilot shall be so installed as to be easily visible to him with the minimum practicable deviation from his normal position and line of vision when he is looking out and forward along the flight path and they shall also be visible to the second pilot.

04.5805. *Gyroscopic instruments.*—All gyroscopic instruments shall derive their energy from engine-driven pumps or from auxiliary power units. Each source of energy supply and its attendant complete installation shall comply with the instrument manufacturer's recommendations for satisfactory instrument operation. On multi-engine aircraft each instrument shall have two separate sources of energy, either one of which shall be capable of carrying the required load. Engine-driven pumps, when used, shall be on separate engines. The installation shall be such that failure of one source of energy or breakage of one line will not interfere with proper functioning of the instruments by means of the other source.

04.581. *Safety equipment installation.*—



04.5810. *Safety belts.*—Safety belts shall be so attached that no part of the attachment will fail at a load lower than that specified in CAR 04.2640.

04.5811. *Fire extinguishers.*—The portable fire extinguisher specified in CAR 04.510 shall be so installed as to be accessible to the passengers. The two portable fire extinguishers specified in CAR 04.530 shall be so installed that one is readily available to the crew and the other is near the main external cabin door where it shall be readily available to passengers and ground personnel.

04.5812. *Safety belt signal.*—The signal or sign specified in CAR 04.530 shall be suitable for indicating to the passengers, at appropriate times, that the seat belts should be fastened. It shall be located in a conspicuous place and so arranged that it can be conveniently operated from the seat of either pilot.

04.5813. *Landing flares.*—Landing flares shall be releasable from the pilot's compartment. Structural provision shall be made for the recoil loads.

04.5814. *Deicers.*—Positive means shall be provided for the deflation of all wing boots.

04.582. *Electrical equipment installation.*—

04.5820. *General.*—Electrical equipment shall be installed in accordance with accepted practice and suitably protected from fuel, oil, water and other detrimental substances. Adequate clearance shall be provided between wiring carrying appreciable current and fuel and oil tanks, fuel and oil lines, carburetors, exhaust piping and moving parts.

04.5821. *Battery.*—Batteries shall be easily accessible and adequately isolated from fuel, oil and ignition systems. Adjacent parts of the aircraft structure shall be protected with a suitable acid-proof paint if the battery contains acid or other corrosive substance and is not completely enclosed. If the battery is completely enclosed, suitable ventilation shall be provided. All batteries shall be so installed that spilled liquid will be suitably drained or absorbed without coming in contact with the airplane structure.

04.5822. *Fuses.*—Fuses shall be so located that they can readily be replaced in flight. They shall break the current in a generating system at a sufficiently small current flow to adequately protect the lights, radio equipment and other parts of the circuit.

04.5823. *Generator.*—When a generator is specified it shall have sufficient capacity to carry the entire running load. Such generator shall be engine-driven unless an approved equivalent system is provided. Auxiliary power units will be approved in lieu of batteries and engine-driven generators, provided that they are at least two in number and that the supply system is capable of carrying the entire running load with any one unit out of action.

04.58230. *Running load.*—The running load shall be defined as the electric consumption of all lights, radio equipment and other electrical devices except those which are designed only for occasional intermittent use. Examples of devices regarded as intermittent are radio broadcasting equipment, landing lights and electrically operated landing gears and wing flaps. Radio beacon signal receivers and all other lights are considered a part of the constant load.

04.5824. *Anchor lights.*—The anchor light specified for seaplanes and amphibians shall be so mounted and installed that, when the airplane is moored or drifting on the water, it can show a white light visible for at least two miles in all directions.

04.5825. *Landing lights.*—Electric landing lights shall be so installed that at least one shall be not less than 10 feet to the right or left of the first pilot's seat and beyond the swept disk of the outermost propeller. Individual switches for each light shall be provided in the pilot's compartment.

04.5826. *Instrument lights.*—Instrument lights shall be so installed as to provide sufficient illumination to make all flight instruments easily readable and shall be equipped with rheostat control for dimming unless it can be shown that a non-dimming light is satisfactory.

04.5827. *Position lights.*—Position lights shall be so installed as to provide the light intensity and ranges of visi-

bility prescribed in CAR 15 for tail lights and for standard forward position lights, as the case may be. Forward position lights, including auxiliary lights, shall be spaced laterally as far apart as practicable.

04.5828. *Master switch.*—Electrical installations shall incorporate a master switch easily accessible to a member of the crew.

04.583. *Radio equipment installation.*—To be amplified.

04.589. *Miscellaneous equipment installation.*—

04.5890. *Seats.*—Seats or chairs, even though adjustable, in open or closed airplanes, shall be securely fastened in place whether or not the safety belt load is transmitted through the seat.

04.5891. *Accessories.*—Engine-driven accessories on multi-engine aircraft shall be distributed among two or more engines.

04.6. *Powerplant installation.*—

04.60. *Engines.*—Engines shall be of a type and design which has been certificated as airworthy in accordance with the requirements of CAR 13 or shall have been approved as airworthy in accordance with previous regulations, except that engines for use in light airplanes defined in CAR 04.01 need not be certificated or approved but shall have power ratings assigned by the Secretary in accordance with the provisions of CAR 13 or previous regulations.

04.61. *Propellers.*—Propellers shall be of a type and design which has been certificated as airworthy in accordance with the requirements of CAR 14, or shall have been approved as airworthy in accordance with previous regulations, except that wood propellers of a conventional type for use in light airplanes defined in CAR 04.01 need not be certificated. In certain cases maximum engine bore limitations are also assigned to propellers. Propellers may be used on any engine provided that the certified power ratings, speed ratings and bore of the engine are not in excess of the limitations of the propeller as certificated, and further provided that the vibration characteristics of the combination are satisfactory to the Secretary.

04.610. *Controllable pitch.*—The control mechanism shall be designed and equipped with a positive stop which shall limit the minimum pitch so that the take-off crankshaft speed for which the aircraft is certificated is not exceeded during take-off with take-off power unless it is necessary to so locate the stop that a higher crankshaft speed may be used in an emergency. The means provided for controlling the pitch shall be so arranged as to minimize the attention required from a pilot to prevent the engines from exceeding their crankshaft speed limitations under any flight condition.

04.611. *Propeller clearance.*—Propellers shall have a minimum ground clearance of 9 inches when the airplane is in a horizontal position with the landing gear deflected as it would be under the maximum authorized weight of the airplane. Propellers on seaplanes shall clear the water by at least 18 inches when the seaplane is at rest under the maximum authorized load conditions. A clearance of at least 1 inch shall be provided between the tips of propellers and any part of the structure.

04.62. *Fuel systems.*—

04.620. *Capacity and feed.*—The fuel capacity shall be at least 0.15 gallon per maximum (except take-off) horsepower for which the airplane is certificated. Air-pressure fuel systems shall not be used. Only straight gravity feed or mechanical pumping of fuel is permitted. The system shall be so arranged that the entire fuel supply may be utilized in the steepest climb and at the best gliding angle and so that the feed ports will not be uncovered during normal maneuvers involving moderate rolling or side slipping. The system shall also feed fuel promptly after one tank has run dry and another tank is turned on. If a mechanical pump is used, an emergency hand pump of equal capacity shall be installed and available for immediate use in case of a pump failure during take-off. Hand pumps of suitable capacity may also be used for pumping fuel from an auxiliary tank to a main fuel tank.



04.621. *Tank installation.*—No fuel tank shall be placed closer to an engine than the remote side of a fire-wall. At least one-half inch clear air space shall be allowed between the tank and fire-wall. Spaces adjacent to the surfaces of the tank shall be ventilated so that fumes cannot accumulate or reach the crew or passengers in case of leakage. If two or more tanks have their outlets interconnected they shall be considered as one tank and the air space in the tanks shall also be interconnected to prevent differences in pressure at the air vents of each tank of sufficient magnitude to cause fuel flow between tanks. Mechanical pump systems shall not feed from more than one tank at a time except by special ruling from the Secretary.

04.622. *Tank Construction.*—Each fuel tank shall be provided with either a sump and drain located at the point which is lowest when the airplane is in a normal position on the ground or outlets at the bottom of the tank provided with large mesh finger strainers. If a sump is provided, the main fuel supply shall not be drawn from the bottom of this sump. If no sump is provided the system drain shall be controllable from the pilot's compartment and shall act as a tank drain. Each tank shall be suitably vented from the top portion of the air space. Such air vents shall be so arranged as to minimize the possibility of stoppage by dirt or ice formation. When large fuel tanks are used, the size of the vent tubes should be proportioned so as to permit rapid changes in internal air pressure to occur and thereby prevent collapse of the tanks in a steep glide or dive. Tanks of 10 gallons or more capacity shall be provided with internal baffles unless suitable external support is provided to resist surging.

04.623. *Tank strength.*—Fuel tanks shall be capable of withstanding an internal test pressure of  $3\frac{1}{2}$  pounds per square inch without failure or leakage. Fuel tanks of large capacity which have a maximum fuel depth greater than 2 feet shall be investigated for the pressure developed during the maximum *limit* acceleration with full tanks. Tanks shall be so designed, and the rivets or welds so located, as to resist vibration failures or leakage.

04.624. *Gauge.*—A satisfactory gauge shall be so installed on all airplanes as to readily indicate to a pilot or flight mechanic the quantity of fuel in each tank while in flight. When two or more tanks are closely interconnected and vented, and it is impossible to feed from each one separately, only one fuel-level gauge need be installed. If a glass gauge is used, it shall be suitably protected against breakage.

04.625. *Lines and fittings.*—All fuel lines and fittings shall be of sufficient size so that under the pressure of normal operation the flow is not less than double the normal flow required for take-off engine power. A test for proof of compliance with this requirement shall be made. All fuel lines shall be so supported as to prevent excessive vibration and should be located so no structural loads can be applied. Bends of small radius and vertical humps in the lines shall be avoided. Copper fuel lines which have been bent shall be annealed before installation. Parts of the fuel system attached to the engine and to the primary structure of the airplane shall be flexibly connected thereto. Flexible hose connections and fuel lines shall have metal liners or the equivalent. Fittings shall be of a type satisfactory to the Secretary.

04.626. *Strainers.*—One or more strainers of adequate size and design, incorporating a suitable sediment trap and drain, shall be provided in the fuel line between the tank and the carburetor and shall be installed in an accessible position.

04.627. *Valves.*—One or more positive and quick-acting valves that will shut off all fuel to each engine shall be within easy reach of the first pilot and the second pilot or of the flight mechanic. In the case of airplanes employing more than one source of fuel supply, suitable provision shall be made for independent feeding from each source.

04.6270. *Dump valves.*—When fuel tanks are equipped with dump valves, the operating mechanism for such valves shall be within convenient reach of the first pilot and the second pilot, or of the flight mechanic. Dump valves shall be so installed as to provide for safe and rapid discharge of fuel.

04.628. *Drains.*—One or more accessible drains shall be provided at the lowest point on the fuel system to completely drain all parts of each system when the airplane is in its normal position on level ground. Such drains shall discharge clear of all parts of the airplane and shall be equipped with suitable safety locks to prevent accidental opening.

04.629. *Miscellaneous fuel system requirements.*—

04.6290. *Filler openings.*—All filler openings in the fuel system shall be plainly marked with the capacity and the word "fuel." Provision shall be made to prevent any overflow from entering the wing or fuselage.

04.6291. An adequate means shall be provided for preventing the formation of ice in the engine carburetors. (See also 04.532. (j).)

04.63. *Lubrication systems.*—

04.630. *General.*—Each engine shall have an independent oil supply. The oil capacity of the system shall be at least 1 gallon for every 16 gallons of fuel for single-engine aircraft and 1 to 20 for multi-engine aircraft but shall not be less than the minimum specified by the engine manufacturer for safe operation of the engine. A special ruling concerning capacity will be made by the Secretary when oil may be transferred between engines in flight or when a suitable reserve is provided. The suitability of the lubrication system shall be demonstrated in flight tests in which engine temperature measurements are obtained. The system shall provide the engine with an ample quantity of oil at a temperature suitable for satisfactory engine operation.

04.631. *Tank installation.*—Oil tanks shall be suitably vented and shall be provided with an expansion space which cannot be inadvertently filled with oil. Such expansion space shall be at least 10 per cent of the total tank volume, except that it shall in no case be less than one-half gallon.

04.632. *Tank strength.*—Oil tanks shall be capable of withstanding an internal test pressure of 5 pounds per square inch without failure or leakage. Tanks shall be so designed and the rivets or welds so located as to resist vibration failures and leakage.

04.633. *Gauge.*—A suitable means shall be provided to determine the amount of oil in the system during the filling operation.

04.634. *Piping.*—Oil piping shall have an inside diameter not less than the inside diameter of the engine inlet or outlet and shall have no splices between connections. Connections in the oil system shall be of a type satisfactory to the Secretary.

04.635. *Drains.*—One or more accessible drains shall be provided at the lowest point on the lubricating systems to drain completely all parts of each system when the airplane is in its normal position on level ground. Such drains shall discharge clear of all parts of the airplane and shall be equipped with suitable safety locks to prevent accidental opening.

04.636. *Oil temperature.*—A suitable means shall be provided for measuring the oil temperature at the engine inlet.

04.637. *Filler openings.*—All filler openings in the oil system shall be plainly marked with the capacity and the word "oil".

04.64. *Cooling systems.*—

04.640. *General.*—The cooling system shall be of sufficient capacity to maintain engine temperatures within safe operating limits under all conditions of flight during a period at least equal to that established by the fuel capacity of the aircraft, assuming normal engine power and speeds. Compliance with this requirement shall be demonstrated in flight tests in which engine temperature measurements are obtained under critical flight conditions including flight with one or more engines inoperative.



04.641. *Radiators.*—Radiators shall be so mounted as to reduce vibration and eliminate strains causing distortion.

04.642. *Piping.*—Piping and connections shall conform to accepted standards and shall not transmit vibration to the radiator or the structure of the aircraft.

04.643. *Drains.*—One or more accessible drains shall be provided at the lowest points on the cooling system to drain completely all parts of such system when the airplane is in its normal position on level ground. Such drains shall discharge clear of all parts of the airplane and shall be equipped with suitable safety locks to prevent accidental opening.

04.644. *Filler openings.*—All filler openings in the cooling system shall be plainly marked with the capacity of the system and the name of the proper cooling liquid.

04.65. *Powerplant instruments, controls and accessories.*—

04.650. *Instruments.*—The engine instruments required are specified in CAR 04.5. The installation requirements for navigation instruments in CAR 04.5804 shall apply to tachometers and manifold pressure gauges. All other instruments shall be visible in flight to the pilot and co-pilot or to the flight mechanic. If the manifold pressure gauges and tachometers are not visible to the flight mechanic, he shall be provided with a duplicate set of these instruments.

04.651. *Controls.*—All powerplant controls, including those of the fuel system, shall be plainly marked to show their function and method of operation.

04.6510. *Throttle controls.*—Throttle controls shall be easily accessible to both pilots and shall be so arranged as to afford a positive and immediately responsive means of controlling all engines separately or simultaneously. Flexible throttle control systems shall be of a certificated type. A forward movement shall open the throttle.

04.6511. *Ignition switches.*—Ignition switches shall be easily accessible to both pilots. A positive means for quickly shutting off all ignition of multi-engine aircraft, by grouping of switches or otherwise, shall be provided.

04.6512. *Propeller pitch controls.*—Separate pitch controls shall be provided for each propeller.

04.652. *Accessories (airline carriers).*—(See CAR 04.5891.)

04.66. *Manifolding, cowlings and firewall.*—

04.660. *General.*—All manifolds, cowlings and firewalls shall be so designed and installed as to reduce to a minimum the possibility of fire either during flight or following an accident and shall therefore comply with accepted practice in all details of installation not hereinafter specified.

04.661. *Manifolds.*—Exhaust manifolds shall be constructed of suitable materials, shall provide for expansion, and shall be arranged and cooled so that local hot points do not form. Gases shall be discharged clear of the cowlings, airplane structure and fuel system parts of drains. They shall not blow back on the carburetor air intake or the pilot or passengers, nor cause a glare ahead of the pilot at night. No exhaust manifolding shall be located immediately adjacent to or under the carburetor or fuel system parts liable to leakage.

04.662. *Air intakes.*—Carburetor air intakes shall be suitably drained and shall open completely outside the cowlings unless the emergence of back-fire flames is positively prevented. The drain shall not discharge fuel in the path of possible exhaust flames.

04.663. *Engine cowlings.*—All cowlings around the powerplant and on the engine side of the firewall shall be made of metal and shall be so arranged that any accumulations of dirt, waste or fuel may be observed without complete removal of the cowlings. It shall fit tightly to the firewall, but openings may be provided if the airplane surface within 15 inches thereof is protected with metal or other suitable fireproofing material. The cowlings shall be completely and suitably drained in all attitudes of flight and on the ground, with separate drains provided for the parts of the fuel system liable to leakage. All such drains shall be so located as to prevent fuel or oil from dripping onto the exhaust manifold or any parts of the aircraft and from permeating any material of a cellular nature.

04.664. *Firewall.*—A firewall shall be provided unless the engine is mounted in an isolated nacelle with no fuel tanks. Such fire bulkhead shall be constructed in either of the following approved manners:

(a) A single sheet of terne-plate not less than 0.028" thick.

(b) A single sheet of stainless steel not less than 0.015" thick.

(c) Two sheets of aluminum or aluminum alloy not less than 0.02" thick fastened together and having between them an asbestos paper or asbestos fabric sheet at least  $\frac{1}{8}$ " thick.

04.6640. The firewall shall completely isolate the engine compartment and shall have all necessary openings fitted with close-fitting grommets or bushings. Adjacent inflammable structural members shall be protected by asbestos or an equivalent insulating material and provision shall be made for preventing fuel and oil from permeating it.

04.665. *Heating systems.*—Heating systems involving the passage of cabin air over or in close proximity to engine exhaust manifolds shall not be used unless adequate precautions are incorporated in the design to prevent the introduction of carbon monoxide into the cabin or pilot's compartment. They shall be constructed of suitable materials, be adequately cooled and be susceptible to ready disassembly for inspection.

04.67. (Unassigned.)

04.68. (Unassigned.)

04.69. *Miscellaneous powerplant requirements.*—

04.690. *Materials.*—Fuel, oil and cooling systems shall be made of materials which, including their normal or inherent impurities, will not react chemically with any fuels, oils or liquids that are likely to be placed in them.

04.7. *Performance.*—

04.70. *Performance requirements.*—All airplanes shall comply with the following performance requirements, in standard atmosphere, at all weights up to and including the standard weight (CAR 04.102), and under all loading conditions within the center of gravity range certified (CAR 04.742). There shall be no flight characteristics which, in the opinion of the Secretary, render the airplane unairworthy.

04.700. *Landing speeds.*—The landing speed with power off, in standard calm air at sea level, shall not exceed a value determined as follows:

(a) Airplanes certificated for passenger carrying:

65 miles per hour for airplanes of 20,000 pounds standard weight or less,

70 miles per hour for airplanes of 30,000 pounds standard weight or more, and a linear variation with standard weight shall apply for airplanes between 20,000 and 30,000 pounds.

(b) Airplanes which are certificated for the carriage of goods only:

The above landing speed values may be increased 5 miles per hour.

04.701. *Take-off.*—

04.7010. Landplanes shall take-off within 1,000 feet in standard calm air at sea level.

04.7011. Seaplanes shall take-off from the water at sea level in 45 seconds or less with a wind velocity not exceeding 10 miles per hour and under moderately smooth water conditions.

04.702. *Climb.*—

04.7020. Landplanes shall climb, in feet the first minute after leaving the ground, at least 8 times the calculated stalling speed in miles per hour, but not less than 300 feet.

04.7021. Seaplanes shall climb, in feet the first minute after leaving the water, at least 6 times the calculated stalling speed in miles per hour, but not less than 250 feet.

04.703. *Controllability and maneuverability.*—All airplanes shall be controllable and maneuverable under all power



conditions and at all flying speeds between minimum flying speed and the maximum certified speed. All airplanes shall have adequate control in a landing at minimum landing speed with power off. Airplanes equipped with conventional gear shall comply with the foregoing requirement in a three-point landing.

**04.704. Balance.**—As used in these regulations the term "balanced" refers to steady flight in calm air without exertion of control force by the pilot or automatic pilot. Lateral and directional balance is required at cruising speed, which for this purpose shall be taken as 90 per cent of the high speed in level flight. Longitudinal balance is required under the following flight conditions:

(a) *Power on.*—In level flight, at all speeds between cruising speed and a speed 20 per cent in excess of stalling speed. In a climb, at maximum (except take-off) horsepower and a speed 20 per cent in excess of stalling speed.

(b) *Power off.* In a glide, at a speed not in excess of 140 per cent of the maximum permissible landing speed or the placard speed with flaps extended, whichever is lower, under the forward center of gravity position approved with maximum authorized load and under the most forward center of gravity position approved, regardless of weight.

**04.705. Stability.**—Under all power conditions all airplanes shall be longitudinally, laterally and directionally stable. An airplane will be considered to be longitudinally stable if, in stability tests, the amplitude of the oscillations decreases.

**04.706. Spinning.**—All airplanes shall be able to recover from a 6-turn spin in no more than 1½ additional turns with controls neutral, with power off and with the stabilizer or other trimming device set for balance at cruising speed in level flight with the particular load. During the spin the control surfaces shall exert no back pressure on the control column.

**04.7060. Abnormal spins.**—When a spin is obtained by movements of the controls which the inspector considers to be abnormal and unjustifiably severe for operating maneuvers, the use of elevator and rudder will be permitted for recovery after 6 turns. An airplane of this type will be acceptable insofar as spin characteristics are concerned provided recovery can be made in not more than 2 additional turns with ailerons in neutral, and further provided that a normal spin either conforms with the normal requirements or is impossible to perform.

**04.7061.** An airplane of more than 4,000 pounds standard weight will not be subjected to the spin test unless the flight characteristics of the particular airplane are, in the opinion of the Secretary, such as to indicate the advisability of a spin test.

**04.707. Flutter and vibration.**—Wings, tail surfaces, control surfaces and primary structural parts shall be free from flutter or objectionable vibration in all normal attitudes or conditions of flight at all speeds between the minimum flying speed and the maximum certified speed.

**04.708. Ground and water characteristics.**—Landplanes shall be maneuverable on the ground and shall be free from dangerous ground looping tendencies and objectionable taxiing characteristics. The seaworthiness and handling characteristics of seaplanes and amphibians shall be demonstrated by tests deemed appropriate by the Secretary. (See CAR 04.452 for water stability requirements.)

**04.71. Modified performance requirements for airline carriers.**—For multi-engine airline aircraft operating in accordance with the requirements of CAR 61 the weight may be increased beyond the values corresponding to the landing speed specified in CAR 04.700 and the take-off requirements of CAR 04.701, subject to the following conditions.

**04.710.** The increased weight shall be known as the *provisional weight*. (Car 04.103.) The *standard weight* (CAR 04.102) shall be the maximum permissible weight for all operations other than those in accordance with the require-

ments of CAR 61. The *provisional weight* shall be the maximum permissible weight for any operation.

**04.711.** Compliance with all the airworthiness requirements except landing speed and take-off is required at the *provisional weight*, except that the *provisional weight* may exceed the *design weight* on which the structural loads for the landing conditions are based by an amount not greater than 15 per cent, provided that the airplane is shown to be capable of safely withstanding the ground or water shock loads incident to taking-off at the *provisional weight*.

**04.712.** The aircraft shall be provided with suitable means for the rapid and safe discharge of a quantity of fuel sufficient to reduce its weight from the *provisional weight* to the *standard weight*.

**04.713.** In no case shall the *provisional weight* exceed a value corresponding to a landing speed of 5 miles per hour in excess of that specified in CAR 04.700.

**04.714.** Aircraft engaged in operations in accordance with the requirements of CAR 61 shall be certificated for the weight at which they comply with the take-off and other performance provisions of those regulations for the particular operation involved provided that such certified weight shall not exceed the *provisional weight*. It may, however, be less than the *provisional* or *standard weights*, dependent upon the ground or water facilities and the nature of the route flown.

#### 04.72. Performance tests.—

**04.720. General.**—Compliance with the foregoing performance requirements shall be demonstrated by means of suitable tests of the type airplane. Additional tests for airline carriers are specified in CAR 04.73. Computations are not acceptable as proof of compliance with the requirements, but shall be used for correcting flight test data to standard atmospheric conditions and may be used to estimate the effects of minor changes. The methods of performance calculation and correction employed shall be subject to the approval of the Secretary.

**04.7200.** The applicant shall provide a person holding an appropriate commercial pilot certificate to make the flight tests, but a designated Bureau inspector may pilot the airplane during such parts of the tests as he may deem advisable.

**04.7201.** In the event that the applicant's test pilot is unable or unwilling to conduct any of the required flight tests, the tests shall be discontinued until the applicant furnishes a competent pilot.

**04.7202.** Parachutes shall be worn by members of the crew during the flight tests.

**04.7203.** The applicant shall submit to the Bureau inspector a report covering all computations and tests required in connection with calibration of flight instruments and correction of test results to standard atmospheric conditions. The inspector will conduct any flight tests which appear to him to be necessary in order to check the calibration and correction report or to determine the airworthiness of the airplane.

**04.721. Loading conditions.**—The loading conditions used in performance tests shall be such as to cover the range of loads and center of gravity positions for which the airplane is to be certificated.

**04.7210. Use of ballast.**—Ballast may be used to enable airplanes to comply with the flight test requirements as to longitudinal stability, balance and landing in accordance with the following provisions:

**04.72100 (a).** Ballast shall not be used for this purpose in airplanes having a gross weight of less than 5000 pounds nor in airplanes with a total seating capacity of less than 7 persons.

**04.72101 (b).** The place or places for carrying ballast shall be properly designed and installed and plainly marked.

**04.72102 (c).** The loading schedule which will accompany each certificate issued for an airplane requiring special loading of this type shall be conspicuously posted in either the pilot's compartment or in or adjacent to the ballast compartments and strict compliance therewith will be required of the airplane operator.



04.7211. *Fuel to be carried.*—When low fuel adversely affects balance or stability, the airplane shall be so tested as to simulate the condition existing when the amount of fuel on board does not exceed one gallon for every 12 maximum (except take-off) horsepower of the engine or engines installed thereon. When the engine is limited to a lower power, the later shall be used in computing low fuel.

04.722. *Maximum airspeed.*—The flight tests shall include steady flight at the maximum certified airspeed. Such tests shall in no case involve indicated airspeeds in excess of 90 per cent of the design gliding speed ( $V_0$ ) for which compliance with the structural loading requirements (CAR 04.21) has been proved. When  $V_0$  is greater than  $1.33 V_L$  (CAR 04.111) the flight tests need not be conducted beyond an indicated airspeed equal to  $1.2 V_L$ , provided that the operation limits are correspondingly fixed (see CAR 04.743). The maximum indicated airspeed to be certified for operation of high-lift devices shall also be suitably demonstrated in flight. Recovery from glides or dives at the maximum certified airspeed shall be made in a gentle manner.

04.723. *Emergency ceiling (multi-engine airplanes only).*—Multi-engine airplanes, except airline carriers as provided for in CAR 04.73, shall be flight tested to determine the altitude at which level rectilinear flight may be maintained with any one engine inoperative, the remaining engine or engines operating at the maximum (except take-off) power. In this test the standard weight shall be carried.

04.724. *Airspeed indicator calibration.*—In accordance with CAR 04.5800, the airspeed indicator of the type airplane shall be calibrated in flight. The method of calibration used shall be subject to the approval of the Secretary.

04.725. *Check of fuel system.*—The operation of the fuel system shall be checked in flight to determine its effectiveness under low fuel conditions and after changing from one supply tank to another. (See CAR 04.620.) For such tests low fuel is defined as approximately 15 minutes supply at the maximum (except take-off) power certified.

04.73. *Additional performance tests for airline carriers.*—The performance characteristics of airplane certificated as airline carriers shall be determined in accordance with the following requirements, which are additional to those specified under CAR 04.72. From the results obtained in the following tests, the applicant shall submit complete computations and tabulated or charted data which shall show the take-off and landing characteristics (including angles of climb and glide) for various load conditions up to a standard altitude of 8,000 feet, and, with one engine shut off or throttled, rates of descent as related to airspeed between the usable ceiling (see CAR 04.732 (a)) and an altitude of 4,000 feet higher.

04.730. *Take-off.*—With all engines functioning normally the following characteristics shall be obtained in relatively calm air (wind velocity not to exceed approximately 5 miles per hour) at each of two altitudes differing by at least 3,000 feet:

- (a) The best angle<sup>1</sup> of steady climb and the corresponding flight path speed with light load<sup>2</sup> and at the maximum authorized weight, with the engines operating at authorized maximum (except take-off) power, and with the landing gear, if retractable, fully retracted.
- (b) The horizontal distances required for acceleration from a standing start to the speeds determined under the foregoing sub-paragraph (a) with light load and at the

maximum authorized weight, with the landing gear in the extended position.

(c) The horizontal distance required for acceleration from a standing start to the speeds determined under item (a) of CAR 04.731 with light load and at maximum authorized weight, with the landing gear in the extended position.

04.731. *Climb.*—The following characteristics shall be determined at each of two altitudes differing by at least 3,000 feet with the ignition switch of one engine shut off and the remaining engine or engines operating at the authorized take-off power and with the landing gear fully extended, the propeller of the shut-off engine being set for take-off:

(a) The speed of best angle of steady climb with one engine shut off with light load and at the maximum authorized weight.

(b) The best angle of steady climb with conditions as in (a) above.

04.732. *Flight with inoperative engine.*—The following characteristics shall be determined with the ignition switch of one engine shut off or with one engine throttled, whichever results in a lower ceiling, and with the remaining engine or engines operating at the maximum (except take-off) power.

(a) The usable ceiling which, for this purpose, shall be defined as the altitude at which the best rate of climb is 50 feet per minute, with light load and at the maximum authorized weight.

(b) The speed in level flight, at the usable ceiling at maximum authorized weight.

(c) Rates of descent as related to airspeed, from an altitude 4,000 feet above the usable ceiling determined in (a) above, with light load and at maximum authorized weight.

04.733. *Approach and landing.*—The following characteristics shall be determined in relatively calm air (wind velocity not to exceed approximately 5 miles per hour) at each of two altitudes differing by at least 3,000 feet. The engines shall be fully throttled, the propellers (if controllable) in low pitch, and the wing flaps or similar devices used to the maximum extent.

(a) The normal gliding angle for landing approach at maximum authorized weight at a speed at least 10 miles per hour above the minimum landing speed. (The airspeed at which this is made shall be noted.)

(b) The length of ground run required to come to a full stop after landing from the test for condition (a) above, using brakes.

04.734. *Proving tests.*—See CAR 40 for special tests required for airline carriers which are to be certificated for passenger carrying.

04.74. *Operation limitations.*—

04.740. *Weight.*—Airplanes may be certificated at a maximum authorized weight which is not sufficient to permit carrying simultaneously the full fuel and full pay load, provided that such weight shall be sufficient to provide a gasoline load of at least 0.15 gallon per certified maximum (except take-off) horsepower, with all seats occupied and with sufficient oil for this amount of fuel.

04.741. *Provisional weight (airline carriers).*—(See CAR 04.71.)

04.742. *Center of gravity limitations.*—The maximum variation in the location of the center of gravity for which the airplane is certificated to be airworthy shall be established. Means shall be provided, when necessary in the opinion of the Secretary, by which the operator is suitably informed of the permissible loading conditions which result in a center of gravity within the certified range.

<sup>1</sup> Best angle of climb is defined as the angle corresponding to the maximum attainable ratio of vertical speed to flight path speed.

<sup>2</sup> Wherever light load is referred to in this section it shall be interpreted as representing the lightest weight at which the aircraft can safely be flown, i. e., the empty aircraft plus crew, ballast if necessary, and the amount of fuel and oil necessary for the tests.



04.743. *Air speed limitations.*—The maximum certified air-speed shall be limited to a value at least 10 per cent less than the maximum indicated air speed attained in official flight tests. (See CAR 04.722.) The effects of auxiliary devices shall be similarly accounted for when their operation lowers the safe operating speeds. Means shall be provided by which the pilot is suitably informed of the necessary speed limitations.

04.7430. When the design power (CAR 04.105) used in determining structural loading conditions is less than the maximum (except take-off) power for which the engine is certified, the cruising speed shall be limited to a value at least 10 per cent less than the  $V_L$  (CAR 04.111) corresponding to the design power used.

04.744. *Powerplant limitations.*—The operations for which engines and propellers are certificated shall be limited to conform with the requirements of CAR 04.260 and to prevent damage to the engines during take-off or flight. Means shall be provided to effect such limitations or to inform the operating personnel thereof.

04.8. (Unassigned.)

04.9. *Miscellaneous requirements.*—

04.90. *Standard weights.*—In computing weights the following standard values shall be used:

Gasoline, 6 lbs. per gallon.

Lubricating Oil, 7.5 lbs. per gallon.

Crew and Passengers, 170 lbs. per person.

Parachutes, 20 lbs. each.

04.91. *Leveling means.*—Adequate means shall be provided for easily determining when the aircraft is in a level position.

TABLE 04-1.—Symmetrical flight conditions (flaps retracted)

1. Condition	I	II	III	IV	V	VI
2. Reference CAR 04	0.2131	0.2132	0.2133	0.2134	0.2135	0.2136
3. Design speed (see CAR 04.211)	$V_L$	$V_L$	$V_L$	$V_L$	$V_L$	$V_L$
4. Gust velocity, $U$ , fps. <sup>1</sup>	+30	-30	+15	-15	-	-
5. $\Delta n$ (a) Gust <sup>2</sup>	CAR	CAR	CAR	CAR	- $5\Delta n_{III}$	-
5. $\Delta n$ (b) Maneuvering	04.2121	04.2121	04.2121	04.2121	- $25\Delta n_{III}$	-
6. Limit load factor, $n$ . When line 5 gives two values of $\Delta n$ , use larger.	Fig. 04-3	-	-	-	-	-
7. Minimum value of $n$	$1+\Delta n_{II}$	$1+\Delta n_{II}$	$1+\Delta n_{III}$	$1+\Delta n_{IV}$	$-1\Delta n_{V}$	-
8. Minimum yield factor of safety, $j_y$	2.50	None	2.00	None	1.5	None
9. Minimum ultimate factor of safety, $j_u$	1.0	1.0	1.0	1.0	1.0	1.0
	1.5	1.5	1.5	1.5	1.5	1.5

<sup>1</sup> Feet per second.

<sup>2</sup> + means upward, - means downward.

<sup>3</sup> May be limited by maximum dynamic lift coefficient obtainable under sudden changes of angle of attack.

TABLE 04-2.—Symmetrical flight conditions (flaps extended)

1. Condition	VII	VIII	IX
2. Reference CAR 04			
3. Design speed (see CAR 04.211)	0.2141	0.2142	0.2143
4. Gust velocity, $U$ , fps (°) (°)	$V_L$	$V_L$	$V_L$
5. $\Delta n$ (°)	+15	-15	-
6. Limit load factor, $n$	CAR	CAR	CAR
7. Minimum value of $n$	04.2121	04.2121	04.2121
8. Minimum yield factor of safety, $j_y$	$1+\Delta n_{VII}$	$1+\Delta n_{VIII}$	-
9. Minimum ultimate factor of safety, $j_u$	2.00	None	None
	1.0	1.0	1.0
	1.5	1.5	1.5

<sup>1</sup> Feet per second.

<sup>2</sup> + means upward, - means downward.

<sup>3</sup> May be limited by maximum dynamic lift coefficient obtainable under sudden changes of angle of attack.

TABLE 04-3.—Loading conditions for horizontal tail surfaces

1. Condition	Balancing	Maneuvering	Damping	Tab effects
2. CAR reference 04				
3. Design speed (See CAR 04.211)	0.2210	0.2211	0.2212	0.2213
4. Force coefficient, $C_n$		$V_L$		$V_L$
5. Average Limit pressure, p. s. f. <sup>1</sup>		-55 (down)		
6. Chord distribution		+35 (up)		
7. Span distribution	Fig. 04-4	Fig. 04-5	Fig. 04-6	Fig. 04-5 <sup>2</sup>
8. Minimum average limit pressure, p. s. f. <sup>1</sup>	Constant $C_n$	Constant $C_n$	Constant $C_n$	Constant $C_n$ <sup>3</sup>
9. Special requirements	15	15	15	15
10. Minimum yield factor of safety, $j_y$	None	None	None	None
11. Minimum ultimate factor of safety, $j_u$	1.0	1.0	1.0	1.0
	1.5	1.5	1.5	1.5

<sup>1</sup> Over entire horizontal tail.

<sup>2</sup>  $Q_p$  is the dynamic pressure corresponding to  $V_p$ , see CAR 04.118.

<sup>3</sup> Refers to main surface, disregarding tab; uniform pressure distribution may be assumed over tab.

TABLE 04-4.—Loading conditions for vertical tail surfaces

1. Condition	Maneuvering	Damping	Gust	Tab effects
2. CAR reference 04				
3. Design speed (see CAR 04.211)	0.2220	0.2221	0.2222	0.2223
4. $C_n$ or gust	$V_L$	$V_L$	$V_L$	$V_L$
5. Average limit pressure, p. s. f. <sup>1</sup>	$C_n=0.45$			
6. Chord distribution	$C_n q_p$			
7. Span distribution	Fig. 04-5	Fig. 04-6	Fig. 04-6	Fig. 04-5 <sup>2</sup>
8. Minimum average limit pressure, p. s. f. <sup>1</sup>	Constant $C_n$	Constant $C_n$	Constant $C_n$	Constant $C_n$ <sup>3</sup>
9. Special requirements	12	12	12	12
10. Minimum yield factor of safety, $j_y$	04.2220 (b)	None	None	None
11. Minimum ultimate factor of safety, $j_u$	1.0	1.0	1.0	1.0
	1.5	1.5	1.5	1.5

<sup>1</sup> Over entire vertical tail.

<sup>2</sup>  $Q_p$  is the dynamic pressure corresponding to  $V_p$ , see CAR 04.118.

<sup>3</sup> See 04.2220 (a) for exception.

<sup>4</sup> See 04.2223 (a) for exception.

<sup>5</sup> See 04.2222 (c).

<sup>6</sup> Refers to main surface, disregarding tab; uniform pressure distribution may be assumed over tab.

TABLE 04-5.—Loading conditions for ailerons

1. Condition	Maneuvering	Tab effects
2. CAR reference 04		
3. Design speed (see CAR 04.211)	0.2230	0.2231
4. $C_n$ or gust	$V_L$	$V_L$
5. Average limit pressure, p. s. f.	$C_n=0.45$	
6. Chord distribution	$C_n q_p$	
7. Span distribution	Fig. 04-7	Fig. 04-7 <sup>4</sup>
8. Minimum average limit pressure, p. s. f.	Constant $C_n$	Constant $C_n$ <sup>4</sup>
	12	12

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TABLE 04-5.—Loading conditions for ailerons—Continued

1. Condition	Maneuvering	Tab effects
9. Special requirements		
10. Minimum yield factor of safety, $j_y$	04.2230 (b)	None
11. Minimum ultimate factor of safety, $j_u$	1.0	1.0
	1.5	1.5

<sup>1</sup> See 04.2230 (a) for exception.

<sup>2</sup>  $Q_p$  is the dynamic pressure corresponding to  $V_p$ , see CAR 04.118.

<sup>3</sup>  $V_L$  is the maximum level flight air speed with any engine inoperative.

<sup>4</sup> Refers to main surface, disregarding tab; uniform pressure distribution may be assumed over tab.



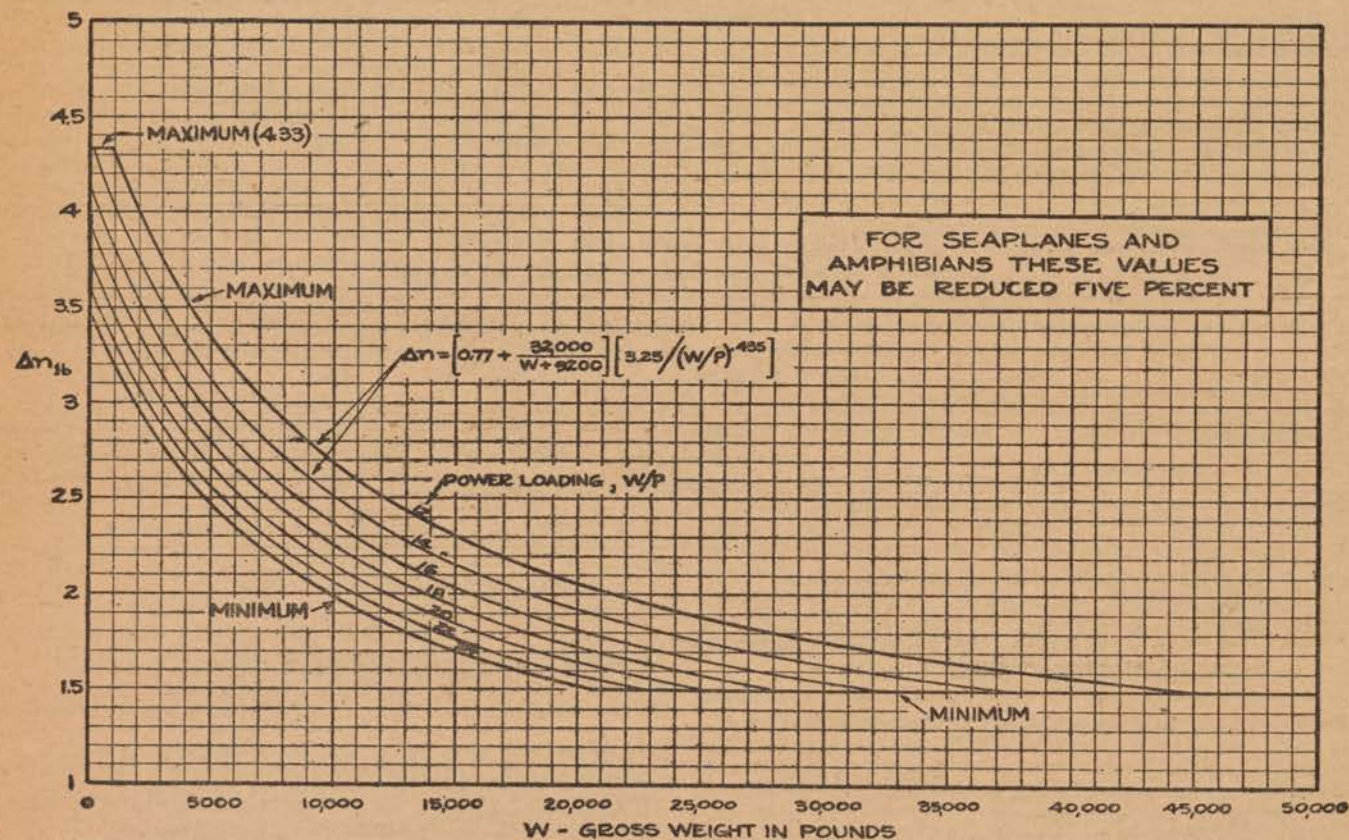
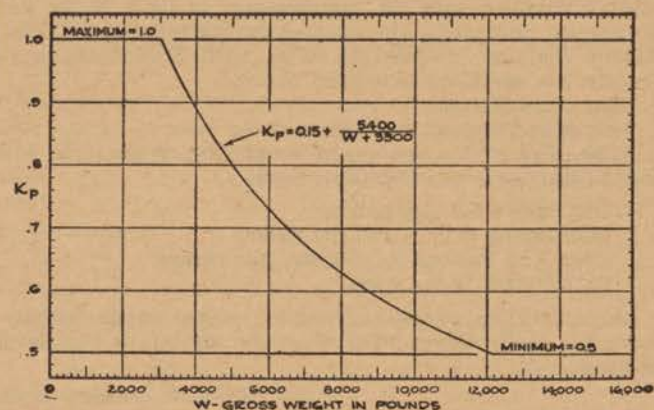
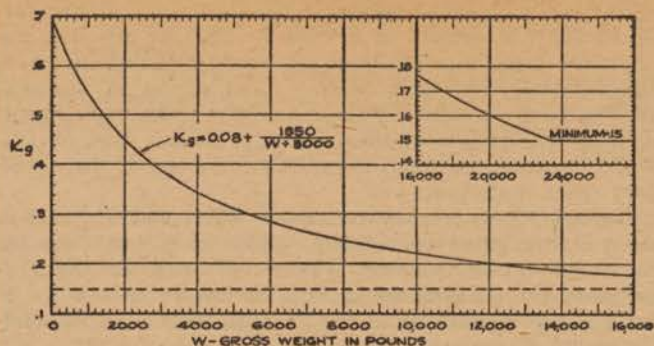
TABLE 04-6.—Loading conditions for control systems (see CAR 04.230)

	Elevator	Rudder		Aileron	Flaps tabs, etc.
		Symmetrical <sup>1</sup> thrust	Unsymmetrical <sup>2</sup> thrust		
1. CAR Reference 04.	0.231	0.232	0.232	0.233	0.234
2. Maximum limit control force, pounds.	200	200	200	80	None
3. Minimum limit control force, pounds.	Fig. 04-8	130	200	Fig. 04-9	See Ref.
4. Minimum yield factor of safety, $j_y$ .	1.0	1.0	1.0	1.0	1.0
5. Minimum ultimate factor of safety, $j_u$ .	1.5	1.5	1.5	1.5	1.5

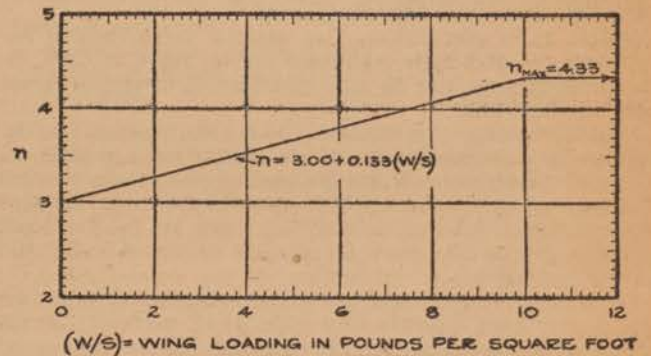
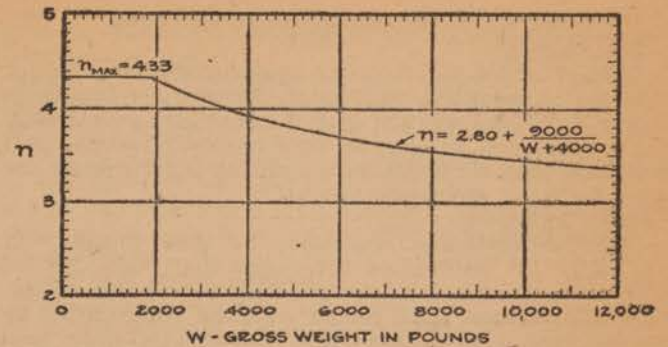
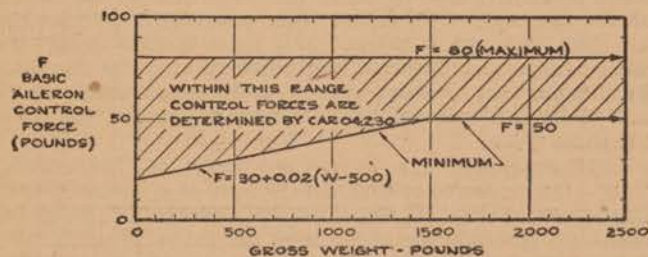
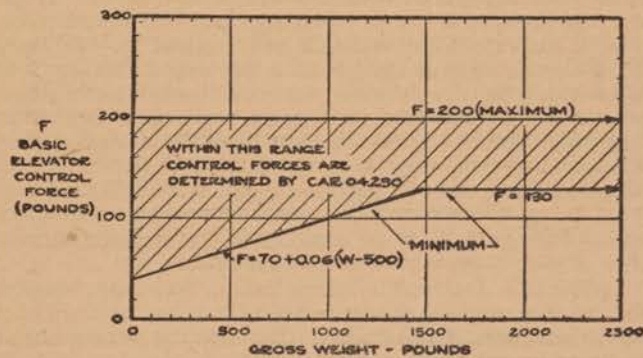
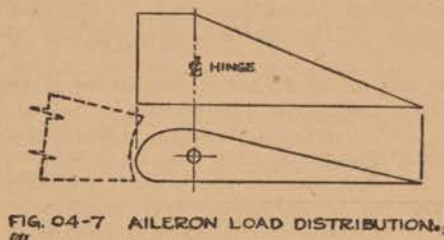
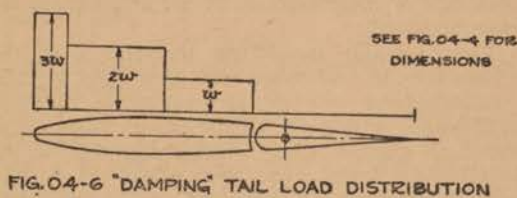
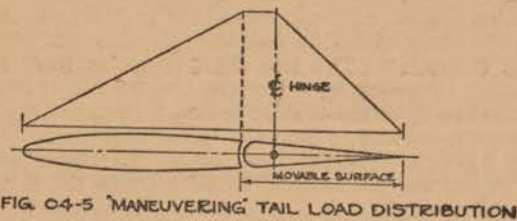
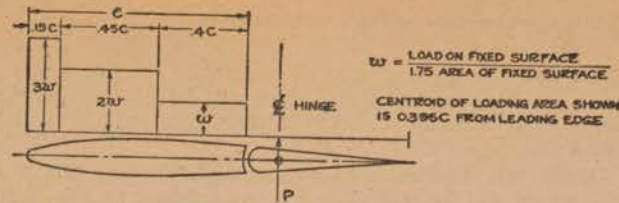
<sup>1</sup> Propeller axes all in plane of symmetry.<sup>2</sup> Propeller axes not all in plane of symmetry.

TABLE 04-7.—Additional (multiplying) factors of safety (see CAR 04.27)

Item component	CAR reference 04	Additional yield factor of safety, $j_y$	Additional ultimate factor of safety, $j_u$	May be covered by item no.
1. Fittings.	0.271	None	1.20	2, 4, 5, 6, 7, 8, 9
2. Castings.	.272	None	2.00	7, 8, 9
3. Parallel double wires in wing lift truss.	.273	None	1.05	4
4. Wires at small angles.	.274	None	See Ref.	
5. Double drag truss wires.	.275	None	See Ref.	
6. Torque tubes used as hinges.	.276	None	1.5	
7. Control surface hinges <sup>1</sup> .	.277	None	6.67	
8. Control system joints <sup>1</sup> .	.277	None	3.33	
9. Wire sizes.	.278	None	See ref.	

<sup>1</sup> For bearing stresses only.





NOTE: USE THE CHART INDICATING THE LOWER VALUE

FIG. 04-10 BASIC LOAD FACTORS FOR LEVEL AND 3-POINT LANDING CONDITIONS

### 13. AIRCRAFT ENGINE AIRWORTHINESS

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## CHAPTER 13. AIRCRAFT ENGINE AIRWORTHINESS

## 13.0. General.—

13.00. *Provision for rating.*—Pursuant to the provisions of the Air Commerce Act requiring the Secretary of Commerce to provide for the rating of aircraft as to their airworthiness, the requirements hereinafter set forth shall be used as a minimum basis for establishing such rating for aircraft engines for use in certificated aircraft.

13.01. *Scope.*—

13.010. *Airworthiness requisites.*—To show eligibility of an engine for certification the engine shall meet the requirements herein as to design, construction and testing. The manufacturer shall comply with the requirements by the submission of technical data and by conducting tests with suitable test equipment. The applicable requirements are set forth in CAR 13.1 through 13.5.

13.011. *Type certificate.*—The general requirements for the issuances of a type certificate are set forth in CAR 01. The procedure relative to type certification of engine is set forth in CAR 13.6.

13.012. *Production certificate.*—The requirements for the issuance of a production certificate are set forth in CAR 01.

13.013. *Deviations.*—When an engine embodies a feature of design or construction which deviates from the practice in conventional internal-combustion types, application shall be made to the Secretary for special rulings covering the feature in question.

13.02. *Light aircraft engines.*—An uncertificated engine for certificated light aircraft (See CAR 04.01 (b)) will be assigned a power rating as to maximum power and speed upon compliance with CAR 13.50.

13.03. *Testing facilities.*—A manufacturer submitting an engine for certification or power rating shall conduct all of the tests and supply or arrange for the testing facilities necessary to show compliance with the requirements contained herein.

13.04. *Military engines.*—An engine of a type which has passed the regular endurance tests of and is approved by the United States Army Air Corps or the Bureau of Aeronautics, Navy Department, may be certificated in accordance with CAR 13.51.

13.05. *Engine operation limits.*—A certificated engine or a power-rated engine shall not be operated at a manifold pressure, crankshaft speed or horsepower greater than assigned thereto by the Secretary.

13.06. *Engine identification plate.*—A plate shall be permanently attached to the engine in such location as to be readily accessible when the engine is installed in aircraft and shall contain the following information: manufacturer's name; name, model designation and serial number of the engine; certified manifold pressure, crankshaft speed and power limits; and minimum octane number of the fuel.

13.07. *Previously approved engines.*—These regulations supersede the requirements for approval of engines set forth in previous regulations. However, engines rated as suitable for use in approved aircraft in accordance with previous requirements may be used in certificated aircraft at the discretion of the Secretary.

13.1. *Design requirements.*

13.10. An engine of more than 100 horsepower shall be equipped with a dual ignition system having at least two spark plugs per cylinder.

13.11. An engine and its accessories shall be so designed and constructed as to reduce to a minimum the chances of failure to function in the air and of fire during flight or in the event of a crash.

13.12. Provision shall be made for the installation of a means for preventing the formation of ice in the carburetor.

13.13. An engine shall operate smoothly with no undue vibration at speeds which may be used for continuous operation.

13.14. The fuel system of an engine shall be of such design that it will continue to supply a satisfactory mixture when tilted to the various angles encountered in normal flight maneuvers.

13.2. *Commercial sea level engine.*—

13.20. *Data required.*—In the case of an engine of a type which has not been previously approved by the Army or Navy, and for which the manufacturer desires the certification of the Secretary, the following information shall be submitted:

13.200. (a). Application for type certificate on Form AC 13-1 which will be furnished for the purpose by the Secretary.

13.201. (b). A test report, satisfactory to the Secretary, including a log and an affidavit, describing in full detail the manufacturer's block test of an engine of the type for which certification is desired. The test shall be of at least 100 hours duration, of which 50 hours shall be at full throttle at an average speed within plus or minus 3 per cent of the proposed rated speed and 50 hours at 75 per cent of the proposed rated power at propeller load speed. The submission of this test report will not be deemed necessary by the Secretary for modified engines of a type previously tested which do not incorporate changes in the general arrangement, number of cylinders or displacement, or an appreciable increase in power or speed.

13.202 (c). Data suitably describing the status of the engine to be used for the endurance test prescribed in CAR 13.23. The manufacturer may use any engine of the type for which certification is desired, regardless of its previous history, provided all defects which became apparent in the 100-hour manufacturer's test have been explained or corrected to the satisfaction of the Secretary. Such data shall include the permissible maximum and normal cylinder head temperatures determined by the manufacturer for the engine.

13.203 (c). A complete set of drawings descriptive of the engine, which drawings shall be numbered and dated, and shall include change letters for each revision. Drawings of small standard commercial parts need not be submitted, but all other drawings applying to the engine, including those of the assembly and installation, shall be included. The materials shall be specified on the drawings by reference to specification numbers of the Army, Navy, S. A. E., or other such recognized standard whenever possible. If the manufacturer refers to his own specification numbers, details of such specifications shall be furnished the Secretary. All drawings shall be folded to a size approximately 9 by 12 inches, with title showing. In order to eliminate a possible source of controversy, the Secretary will not accept drawings which can be altered after approval. Blueprints, photostats or the equivalent are acceptable. If certain of the drawings required for a particular engine are identical with drawings previously submitted and approved in connection with a prior type of engine made by the same manufacturer, such drawings need not be again submitted.

13.204 (e). A complete parts list in duplicate, showing the drawing number, change letter, if any, and name of each component part of the engine. The drawing numbers shall be listed in numerical order.

13.205 (f). A detailed report, supported by affidavit, of a 10-hour flight test of the engine. This test shall include a climb at full throttle to 15,000 feet or to the service ceiling of the airplane. The report shall completely describe the test and the results thereof and shall include dates, the names of persons involved and particulars of the airplane. The engine used for this test may be the same engine as submitted for the endurance test or may be another engine of the same type.

13.21. *Procedure for submitting data and conducting tests.*—Upon receipt of satisfactory data in accordance with CAR 13.200 through 13.202, the Bureau of Air Commerce will authorize an inspector to examine the manufacturer's testing facilities. If the facilities conform to CAR 13.22, the inspector will witness the official tests and tear-down inspection outlined in CAR 13.23 through 13.27. Certification of the engine is then contingent upon the submission by the manufacturer of a satisfactory report signed by the inspec-



tor in accordance with CAR 13.4, and the data described in CAR 13.203 through 13.205.

13.22. *Testing equipment.*—Equipment satisfactory to the Secretary shall be provided by the manufacturer and shall include personnel necessary to conduct the tests outlined in CAR 13.23, 13.24 and 13.25. The following equipment represents a minimum for this purpose:

(a) Electric cradle dynamometer (may be used in conjunction with a water brake absorbing up to 80 per cent of the total horsepower) or torque stand (requires air straightening grid when used for calibration runs). A fixed stand may be used for the endurance test outlined in CAR 13.23.

(b) Propellers suitable for maintaining the speeds and power outputs required.

(c) Tachometer or other accurate means of indicating crankshaft speed. (Counter and stop watch required for frequent checks.)

(d) Manometer for measuring manifold pressure.

(e) Means for measuring engine air intake pressure and temperature.

(f) Oil pressure gauge.

(g) Suitable thermometers to measure oil inlet and outlet temperatures.

(h) Manometer to measure bubble pressure or air speed indicator to measure air velocity over the cylinder head of an air-cooled engine. (Shall be measured at a position approximately half-way between the cylinders and in line with the valve heads when practical.)

(i) Thermocouples for all cylinder heads and barrels of an air-cooled engine. (Shall be located at rear spark plug gasket and near rear cylinder hold-down nut on thrust side.)

(j) Suitable thermometers to measure liquid inlet and outlet temperatures in the case of liquid-cooled engines.

(k) Apparatus for measuring fuel consumption by weight or volume.

(l) Apparatus for measuring oil consumption by weight.

(m) Barometer.

(n) Dry and wet bulb thermometers.

13.23. *Endurance test.*—A 50-hour full throttle endurance test of the engine described in accordance with CAR 13.202 shall be run in periods of at least 5 hours each on consecutive working days except that interruptions to such schedule are permissible if explained to the satisfaction of the Secretary. The test shall be witnessed by an authorized Bureau inspector.

13.230. The engine shall be run at a speed approximately equal to the proposed rated speed and with the manufacturer's recommended setting of the ignition timing, mixture control and intake heat control. The grade of fuel used during the test will be the lowest approved for use in the engine when certificated. Excessive adjustment to the engine or dependence upon excessive fuel or oil consumption for proper cooling during the test will be considered cause for denial of certification by the Secretary.

13.231. Not more than three forced stops caused by the engine shall be allowed during the endurance test. A run of 5 hours shall be added to the test for each forced stop made. Failure of accessories shall not necessarily be considered a forced stop. If the power in a dynamometer run drops as much as 10 per cent, due allowance being made for atmospheric conditions, this shall constitute a forced stop. If a propeller is used to absorb the power during the endurance test, variations in speed of plus or minus 3 per cent are permissible. A variation in speed in excess of this amount due to atmospheric conditions will not be considered a forced stop but the propeller shall be changed to correct for the conditions. Excessive water, fuel or oil leaks developing at the engine shall constitute forced stops. In all cases the Secretary shall be the judge as to what constitutes a forced stop. An engine failure of a type which could cause an immediate forced landing in flight or re-

quire the replacement of a major part of the engine shall terminate the test.

13.232. Complete readings of the performance of the engine shall be recorded at least every half-hour throughout the endurance test. The following readings are essential:

(a) Crankshaft speed in revolutions per minute.

(b) Manifold pressure.

(c) Temperatures of the two hottest cylinder heads and barrels if air-cooled, or of the inlet and outlet liquid if liquid-cooled.

(d) Fuel consumption.

(e) Oil consumption.

(f) Oil inlet and outlet temperatures.

(g) Oil pressure.

(h) Air velocity or pressure difference over the cylinder heads if air-cooled.

(i) Barometric pressure.

(j) Temperature (dry and wet bulb).

(k) Engine air inlet temperature and pressure.

13.24. *Take-off rating.*—If a take-off rating in excess of the endurance test rating is desired, the engine shall be run 10 hours at the take-off power and crankshaft speed. This test may be run as the last 10 hours of the 50-hour endurance test required by CAR 13.23 or as a separate test. The take-off output may be maintained continuously for 5-hour periods or may be maintained for 5 minutes and the engine idled for 5 minutes, consecutively, in which case the duration of the take-off testing shall total 20 hours. Take-off ratings of more than 10 per cent in power or in speed in excess of the endurance test output will require additional tests and a special ruling by the Secretary.

13.25. *Calibration test.*—A full throttle power versus speed calibration of the engine shall be made before or after the endurance test outlined in CAR 13.23 and shall be witnessed by an authorized Bureau inspector.

13.250. Full throttle runs shall be made at crankshaft speed intervals of approximately 100 revolutions per minute from 75 to 110 per cent of the proposed rated speed by varying the load. Each speed shall be maintained for at least 2 minutes, or until operating conditions have stabilized, before a reading is taken.

13.251. The engine shall be operated during the calibration test at the manufacturer's recommended setting of the ignition timing, mixture control and intake heat control. The power rating assigned to the engine by the Secretary will correspond to the corrected horsepower obtained during the calibration test at a crankshaft speed within 25 revolutions per minute of the average speed maintained during the endurance test. This corrected horsepower shall be the observed horsepower corrected to standard conditions for the pressure, temperature and humidity existing in the air intake of the carburetor just ahead of the venturi. Standard conditions are a barometric pressure of 29.92 inches of mercury, an air temperature of 60° F., and a water vapor pressure of 0.39 inch of mercury. It is recommended that a suitable correction, satisfactory to the Secretary, be further applied to the horsepower when the calibration test is conducted with cooling air of a temperature and velocity which differ materially from 60° F. and the velocity normally to be encountered in flight, respectively.

13.252. Essential readings for each run during the calibration test shall be the same as listed in CAR 13.232 except that torque, observed horsepower and corrected horsepower shall be recorded and the oil consumption need not be.

13.26. *Operation test.*—At the conclusion of the endurance or the calibration test the engine shall be operated in the presence of the Bureau inspector at various speeds throughout its operating range to demonstrate the idling, acceleration and running characteristics, which shall be satisfactory to the Secretary.

13.27. *Tear-down inspection.*—After completion of the endurance and calibration tests a complete tear-down and detailed inspection of engine parts shall be made, particular



attention being paid to excessive wear or signs of failure. The Bureau inspector will check the conformity of the engine parts with the set of drawings to be submitted by the manufacturer. As a result of the inspection the Secretary may require, prior to certification, such revisions and additional tests as appear necessary to establish the airworthiness of the engine, or he may deny certification notwithstanding the completion of the tests described in CAR 13.23 and 13.24.

**13.28. Geared engines.**—Complete tests as outlined herein are required for the certification of geared engines. Unless the horsepower loss due to reduction gears is appreciable, a geared engine may, at the option of the engine manufacturer, retain the same power rating as a previously approved identical engine with direct drive.

**13.3. Commercial altitude engines.**—

**13.30. Tests.**—An engine which is not designed for full throttle continuous operation at sea level shall be tested and rated as an altitude engine. The requirements for certification of such an engine are identical with those outlined in CAR 13.2 with the following exceptions.

**13.300.** The manufacturer's test outlined in CAR 13.2 may be conducted at proposed rated power instead of at full throttle.

**13.301.** The flight test shall be in accordance with CAR 13.205 (f) except that the engine need not be operated at full throttle below the rated altitude.

**13.302.** The endurance test shall be conducted at a power and speed of at least that at which the manufacturer desires the engine to be rated. In lieu thereof, when the engine is highly supercharged, the test may be conducted at at least the manifold pressure and rated speed which the engine will develop at the proposed rated altitude. In such a case an engine identical except for the supercharged drive shall also be tested at the power and speed at which the manufacturer desires the engine to be rated. When the engine is highly supercharged and is endurance tested at less than rated power, it will be limited for take-off operation to the power developed during this endurance test unless a take-off test in accordance with CAR 13.24 is made to establish the airworthiness of the engine for take-off at higher power.

**13.303.** The calibration test shall consist of the following:

(a) A full throttle calibration at sea level in accordance with CAR 13.25 except that outputs above the proposed rated power need not be maintained 2 minutes before a reading is taken. This calibration may be omitted if the engine is highly supercharged.

(b) Constant speed runs made by varying the load and the throttle to determine curves of horsepower versus manifold pressure. Curves shall be obtained at crankshaft speed intervals of 100 revolutions per minute from 100 revolutions per minute in excess of the proposed rated speed down to the manufacturer's recommended cruising speed of the engine. For each speed, such curves shall extend from approximately 75 per cent of the average manifold pressure of the engine during the endurance test to 110 per cent of such manifold pressure.

**13.31. Altitude rating.**—The rated altitude shall be that altitude at which the engine develops the rated power and speed at full throttle under standard altitude conditions with the grade of fuel used during the endurance test. When equipment is available, calibration tests simulating altitude conditions shall be made to determine the rated altitude and the characteristics of the engine between the rated altitude and sea level. In lieu of such testing the Secretary will accept such empirical methods of determining the altitude performance of the engine as are substantiated by simulated altitude tests of similar engines or by extensive flight tests. The manufacturer shall in each case submit for the consideration of the Secretary all references, test data and curves upon which the manufacturer's estimate of the altitude performance is based.

**13.32. Limitations applied to altitude engines.**—The manufacturer shall submit to the Secretary suitable curves descrip-

tive of the performance of the engine for take-off, climb, cruising, and high speed at all altitudes between sea level and the rated altitude. It is recommended that these curves be plotted on a single sheet with horsepower versus crankshaft speed or manifold pressure at sea level, and with horsepower versus altitude above sea level. Full speed lines shall be indicated. The manufacturer shall also indicate on these curves the limitations desired. The Secretary will issue limiting instructions for the operation of the engine, a copy of which the manufacturer shall supply with each engine delivered for use in certificated aircraft. CAR 04 outlines the operating limitations applied to altitude engines.

**13.4. Test report.**—The manufacturer of an engine which is tested in accordance with CAR 13.2 or 13.3 shall prepare a suitable report describing the test equipment, testing and tear-down inspection. The report shall be completely descriptive of the test and shall include all essential details. The report shall be signed and sworn to by the responsible representative of the engine manufacturer and shall include the following information:

**13.40 (a).** A description and photographs of the testing equipment. (This description need not be included if a previously submitted report adequately describes the equipment used, in which case reference shall be made to such report.)

**13.41 (b).** A chronological description of the endurance testing, covering the events of each period of running. All irregularities, failures and forced stops shall be fully discussed. A table or chart showing all readings recorded during the test shall be included.

**13.42 (c).** A description of the calibration testing, and a table of all readings and corrections. The results shall be plotted as curves of brake-mean-effective pressure, corrected horsepower, manifold pressure, cylinder head or cooling liquid temperatures and fuel consumption versus crankshaft speed.

**13.43 (d).** A description of the condition of the engine parts as determined from the complete tear-down and detailed inspection of the engine after testing. Photographs of all failures or excessively worn parts shall be included.

**13.44 (e).** Photographs of the engine (front, side, and two three-quarter rear views).

**13.5. Special engines.**—

**13.50. Power-rated engines for light aircraft.**—In the case of engines which are to be installed in light aircraft as defined in CAR 04, and for which the manufacturer desires the Secretary to assign a maximum power and speed rating only, the data submitted shall include the following:

(a) An application for power rating, submitted on the same form as is furnished by the Secretary to applicants for a type certificate. When used for this purpose the form shall be altered by the applicant by crossing out the words "Type Certificate" in the heading and substituting the words "Power Rating".

(b) One set of general assembly drawings sufficiently well-dimensioned to show the general specifications of the engine.

(c) A complete report of a power rating test which shall consist of a 5-hour run on a test stand with the throttle wide open, and at the speed at which a rating is desired. If the corrected horsepower cannot be determined satisfactorily from this test, a calibration test may be made after the 5-hour run. The report shall include a detailed log of the 5-hour test and a description of the test stand and instruments used. Details of the equipment and of the calculations used to determine the corrected horsepower shall also be included.

**13.51. Military engines.**—In the case of an engine of a type which has previously been approved by the Army or Navy and for which the manufacturer desires certification by the Secretary, the following data shall be submitted:

(a) An application as described in CAR 13.200.

(b) A copy of the official Army or Navy endurance test report which was the basis for the military approval,



signed by the Army or Navy representative who witnessed the test. It is not necessary for the manufacturer to submit this report when such report has previously been forwarded to the Secretary through official channels. When the report is being prepared by the military agency the Secretary, to expedite approval, may in the interim accept a copy of the official letter of approval of the engine, which letter shall include the military rating and calibration curves.

(c) Drawings as described in CAR 13.203.

(d) A parts list as described in CAR 13.204.

(e) A report of a flight test as described in CAR 13.205, or a statement from the Army or Navy to the effect that such flight tests have been satisfactorily conducted in the Army or Navy service.

**13.52. Modified engines.**—When a manufacturer desires certification by the Secretary of an engine which embodies a modification of a certified engine of the same manufacturer, data shall be submitted and tests conducted as follows:

**13.520 (a).** If the manufacturer desires to increase the rated power or rated speed, or if the modification is of such extent (in the opinion of the Secretary) as to require endurance testing, the modified engine shall be considered a new design which will be eligible for certification upon compliance with CAR 13.2, 13.3 or 13.51, whichever may apply.

**13.521 (b).** If no increase in rated power or rated speed is involved and the modified engine embodies only a minor modification of the certificated engine, and if technical data are submitted to the Secretary which demonstrate conclusively that the airworthiness of the modified engine is at least equal to that of the certificated engine, data shall be submitted in accordance with CAR 13.200, 13.203 and 13.204, and a report of calibration testing shall be submitted in accordance with CAR 13.25, 13.303, 13.31 or 13.42, whichever may apply.

**13.6. Procedure relative to type certification.**—

**13.60. General.**—The procedure and general requirements for the issuance of a type certificate shall be as prescribed in CAR 01.

**13.61. Sealed drawing list.**—When a type certificate is granted, a drawing list representative of the certificated engine is impressed with the seal of the Bureau of Air Commerce and is returned to the manufacturer. Bureau inspectors may call for, and must have access to, the sealed drawing list and the pertinent drawings when making an inspection at the manufacturer's plant to determine whether the engines as built conform to the approved data.

**13.62. Major changes.**—Any major change from the approved drawings must be approved in advance by the Secretary. A change shall be considered major within the meaning of these regulations if it adversely affects the reliability or increases the power output of the engine. In all doubtful cases the decision of the Secretary will establish the category within which a specific change shall be included.

**13.620. Information accompanying a request for approval** of a major change to a certificated engine shall include sufficient technical data and reports of tests (when necessary) to demonstrate to the satisfaction of the Secretary that the changed engine is airworthy. Reports shall be signed and sworn to by the responsible representative of the manufacturer. When it is deemed necessary by the Secretary, an endurance test witnessed by an authorized Bureau inspector will be required to substantiate the airworthiness of specific changes, and particularly when a change is such as to increase materially the power output of the engine.

**13.63. Minor changes.**—On January 1 and July 1 of each year the holder of an engine type certificate shall submit, for approval and file, drawings pertaining to all the minor changes made to the engine during the preceding 6-month period.

**13.7. Engine parts.**—Only structural engine parts which are approved by the Secretary may be used to modify, maintain or repair certificated engines. Replacement parts

will be approved provided the airworthiness of the replacement part is proven to the satisfaction of the Secretary at least equal to that of the original part by technical data or tests, or both; or provided an engine of the specific type has been equipped with the part and has satisfactorily completed an endurance test as prescribed in CAR 13.23; or provided the manufacturer submits an official Army or Navy report approving the part for the engine. Drawings of the part shall be submitted and the factory of the manufacturer shall be inspected for its suitability to produce the part. If the part supplied constitutes a major modification of the engine when installed, the engine shall be considered a new design and as such will be eligible for certification only on compliance with all of the regulations pertaining thereto.

**13.8. Engine accessories.**—An engine will be tested and certificated as a complete powerplant including all engine accessories that are attached to the engine and are essential for its proper operation in the air. Cowling, exhaust manifold and mufflers need not be included, as these items are subject to inspection and approval in each type installation on certificated aircraft. Propellers, propeller hubs and propeller blades are also subject to separate certification under the requirements outlined in CAR 14.

**13.80. Tests.**—At the time of the endurance tests the Secretary will require such additional tests as may be necessary to determine the airworthiness of the engine with the attached accessories. It is recommended that the manufacturer install on the engine, at the time of the test, the accessories with which he may desire the engine to be certificated. Engines may be certificated with other accessories provided the airworthiness of the engine with such other accessories is demonstrated by sufficient technical data, including certified reports of tests when necessary. Additional endurance tests of the engine as described in CAR 13.3 or 13.4 may be necessary if the accessory change constitutes a major modification of the engine.

**13.81. Certification.**—Engine accessories as described in CAR 13.8 are not eligible for separate certification.

#### 14. AIRCRAFT PROPELLER AIRWORTHINESS

- 14.0 General
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  - 14.02 Hubs and Blades
  - 14.03 Testing Facilities
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  - 14.05 Propeller Operation Limits
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#### CHAPTER 14. AIRCRAFT PROPELLER AIRWORTHINESS

##### 14.0. General.—

**14.00. Provision for rating.**—Pursuant to the provisions of the Air Commerce Act requiring the Secretary of Commerce to provide for the rating of aircraft as to their airworthiness, the requirements hereinafter set forth shall be used as a minimum basis for establishing such rating for aircraft propellers for use on certificated aircraft.

##### 14.01. Scope.—

**14.010. Airworthiness requisites.**—To show eligibility of a propeller for certification the propeller shall meet the requirements herein as to design, construction and testing. The manufacturer shall comply with the requirements by



the submission of technical data and by conducting tests with suitable test equipment. The applicable requirements are set forth in CAR 14.1 through 14.4.

14.011. *Type certificates.*—The general requirements for the issuance of a type certificate are set forth in CAR 01. The procedure relative to type certification of propellers is set forth in CAR 14.5.

14.012. *Production certificate.*—The requirements for the issuance of a production certificate are set forth in CAR 01.

14.013. *Deviations.*—When a propeller embodies a feature of design or construction which deviates from the practice in conventional screw propeller types, application shall be made to the Secretary for special rulings covering the feature in question.

14.02. *Hubs and blades.*—Interchangeable propeller hubs and blades are certificated as separate units and the word "propeller" as herein used applies, where applicable, to a propeller hub and to a blade as well as to a complete propeller.

14.03. *Testing facilities.*—A manufacturer submitting a propeller for certification shall conduct all of the tests and supply or arrange for the testing facilities necessary to show compliance with the requirements contained herein. When, in the opinion of the Secretary, adequate and satisfactory methods of testing other than those outlined herein are available, propellers tested by such methods may be eligible for certification.

14.04. *Military propellers.*—A propeller of a type which has passed the regular endurance tests of and is approved by the United States Army Air Corps or the Bureau of Aeronautics, Navy Department, may be certificated in accordance with CAR 14.3.

14.05. *Propeller operation limits.*—A certificated propeller shall not be operated at a power or propeller shaft speed, or in conjunction with an engine bore, greater than the limits assigned thereto by the Secretary. The Secretary may specify short time operation in excess of these limits for take-off purposes except that neither the power nor the speed limits will be raised by more than 10 per cent without further testing.

14.06. *Propeller identification data.*—A certificated propeller, propeller blade or propeller hub shall have the following information conspicuously displayed upon it: manufacturer's name; name, model designation and serial number of the propeller; and maximum power and maximum speed for which certification has been granted. The identification data shall be permanently attached by means of a plate, stamping, engraving, etching or other such method upon a non-critical surface of the propeller blade or hub. When such data are not visible when the propeller is assembled or installed on an aircraft they shall also be painted or printed on the propeller blade or hub.

14.07. *Previously approved propellers.*—These regulations supersede the requirements for approval of propellers set forth in previous regulations. However, propellers rated as suitable for use in approved aircraft in accordance with previous requirements may be used in certificated aircraft at the discretion of the Secretary.

#### 14.1. *Design requirements.*—

14.10. Propellers shall be so designed as to operate without excessive vibration or flutter and shall be constructed of materials which are suitable for service conditions.

14.11. The surface of a propeller blade shall be smooth and the blade shall be faired with respect to the thickness and the moments of inertia about the major and minor axes, with no abrupt curvature changes or irregularities along the blade. Critical surfaces of a metal propeller hub shall be machined smooth without tool marks and any change in cross section shall be faired with as large a fillet as possible.

14.12. It is recommended that a propeller be so designed that the weakest portion of the propeller blade or hub may be inspected without disassembly and that excessive wear or a partial failure will precede a serious type of failure.

14.13. To facilitate inspection wood propellers shall be so finished that the grain of the wood is visible.

#### 14.2. *Commercial propellers.*—

14.20. *Data required.*—In the case of a propeller of a type which has not been previously approved by the Army or Navy, and for which the manufacturer desires the certification of the Secretary, the following information shall be submitted:

14.200 (a). Application for type certificate on Form AC 14-1 which will be furnished for the purpose by the Secretary.

14.201 (b). A complete set of drawings descriptive of the propeller, which drawings shall be numbered and dated and shall include change letters for each revision. All details of the propeller shall be shown, including the profile and plan form of the blade, the size of blade cross sections at frequent stations, the hub design and the materials of construction. The material shall be specified on the drawings by reference to specification numbers of the Army, Navy, S. A. E. or other recognized standard whenever possible. If the manufacturer refers to his own specification numbers, details of such specifications shall be furnished the Secretary. All drawings shall be folded to a size of approximately 9 by 12 inches, with the title showing. In order to eliminate a possible source of controversy, the Secretary will not accept drawings which may be altered after approval. Blue prints, photostats or the equivalent are acceptable. If certain of the drawings required for a particular propeller are identical with drawings previously submitted and approved in connection with a prior type of propeller made by the same manufacturer, such drawings need not be again submitted.

14.202 (c). A complete parts list in duplicate, showing the drawing number, change letter and name of each component part of the propeller. The drawing numbers shall be listed in numerical order. When only one or two drawings are submitted for compliance with CAR 14.201, it is permissible for the manufacturer to submit these drawings in duplicate in which case a parts list is not required.

14.203 (d). A complete log, supported by an affidavit, describing the manufacturer's tests of the propeller in accordance with CAR 14.21. The log shall include a detailed record of the test with dates; names of persons involved; name and model number of engine, or name, model number and Department of Commerce identification mark of airplane; and hours of testing with corresponding engine speeds. The report shall also include the results of a detailed inspection of the propeller after the test in accordance with CAR 14.23.

14.204 (e). A stress analysis when required by CAR 14.210 or when, in the judgment of the Secretary, the design is sufficiently unconventional to require it.

14.21. *Tests required for propellers other than fixed pitch wood propellers.*—A propeller of such type shall be subjected to a 50-hour endurance block test on an internal-combustion engine rigidly mounted and of the same characteristics as the engine or engines in conjunction with which the propeller will be certificated for use, or on another engine acceptable to the Secretary. The test may be run without a stop or in periods of 5 hours or more each. The cylinder bore of the engine used for the test will determine the maximum bore of the engine with which identical propellers of this type will be certificated for use. The test shall be run at the proposed rated speed of the propeller with the propeller so adjusted as to absorb its proposed rated power. If the engine is not run at full throttle, and horsepower measurements are not possible during the test, manifold pressure readings shall be taken at frequent intervals. A suitable calibration curve shall be used to determine the power absorbed by the propeller during the test. The power rating assigned to the propeller by the Secretary may correspond to the corrected horsepower developed by the engine if the engine used for the test is of the type on which the propeller is to be certificated for use. In the case of a controllable or automatic pitch propeller, the pitch-changing mechanism shall be operated throughout the usable



power range at least once for each hour of the test or the equivalent. The engine may be throttled to prevent overspeeding when changing pitch. After such 50 hours of testing, a controllable or automatic pitch propeller shall also be operated at as close to rated power and speed as possible for periods of 5 minutes each at various pitch settings, i. e., at 1 degree intervals throughout the operating range when the design so permits. All variations in running characteristics of the propeller shall be recorded.

14.210. A propeller of the above type which, in the opinion of the Secretary, is sufficiently similar to a previously certificated propeller of the same manufacturer may be subjected to a 50-hour flight test in lieu of the test outlined in CAR 14.21 provided that its airworthiness is demonstrated to the satisfaction of the Secretary by a comparative stress analysis submitted by the manufacturer. The stress analysis shall compare the pertinent aerodynamic, centrifugal, vibration and torque impulse load differences between the respective propellers by a mathematical comparison, when possible, and by suitable curves plotted with the radius of the propeller as abscissa. Curves descriptive of the fairing of the propellers shall also be included when applicable. Such 50-hour flight test shall be conducted on an engine of equal or greater power and speed than that in conjunction with which the rating is requested. At least 5 hours of the test shall be run at the proposed rated speed of the propeller.

14.211. It is recommended that metal propellers of this type also be tested by suitable methods to determine their natural frequencies within all ranges of major vibrations which are produced by the operation of the engines in conjunction with which such propellers are to be certificated for use. Such frequencies should be determined at all blade angles within the desired operating pitch range of propellers. Data covering these tests should be submitted to the Secretary in the form of curves and tables. The type of frequency should be described and the nodes located for each frequency.

14.22. *Tests required for fixed pitch wood propellers.*—A propeller of such type shall be subjected to a 10-hour endurance block test on an internal-combustion engine, or to a 50-hour flight test. In the case of a block test the entire test shall be run at the proposed rated speed of the propeller. In the case of a flight test at least 5 hours shall be run at the proposed rated speed of the propeller. Such flight test shall be conducted with an engine of equal or greater power and speed than that in conjunction with which the propeller is to be certificated for use.

14.23. *Inspection of a tested propeller.*—As prescribed in CAR 14.203, the log of the flight or block test shall include the results of a detailed inspection of the propeller after the test. Photographs of any failures or suspected failures shall be included. A propeller which fails during the testing is not eligible for certification unless the failure is of a nature such that the strength of the propeller is not impaired and a minor modification to the propeller will preclude the probability of future failures of the same type. Aluminum-alloy propellers shall be etched at all critical portions and then examined for minute cracks with a magnifying glass. Steel propellers shall be subjected to both a magnetic and visual inspection for signs of failure.

14.230. A failure of a metal propeller is defined as actual breakage, cracking or permanent set of any part of any blade, hub, bolt, lock nut, spline or keyway; slipping of a blade in its clamping socket; seizing or pitting of any bearing; or jamming of an automatic or controllable pitch mechanism. A wood propeller will be deemed to have failed if the tipping pulls or cracks, if a glue joint opens, or if there is any local failure or crushing around the hub or a bolt. Similar considerations will apply to propellers of any patented composition or of other than conventional wood or metal construction.

14.3. *Military propellers.*—In the case of a propeller of a type which has previously been approved by the Army or

Navy and for which the manufacturer desires certification by the Secretary, the following data shall be submitted:

(a) An application as described in CAR 14.200.

(b) A copy of the official Army or Navy endurance test report which was the basis for the military approval, signed by the Army or Navy representative who witnessed the test. It is not necessary for the manufacturer to submit this report when such report has been previously forwarded to the Secretary through official channels. When the report is being prepared by the military agency the Secretary, to expedite approval, may in the interim accept a copy of the official letter of approval of the propeller which letter shall include the military rating, the length of test, and the output and model designation of the test engine.

(c) Drawings as described in CAR 14.201.

14.4. *Modified propellers.*—When a manufacturer desires the certification by the Secretary of a propeller which embodies only minor modifications of a certificated propeller of the same manufacturer, data shall be submitted as follows:

(a) An application as described in CAR 14.200.

(b) Drawings as described in CAR 14.201.

(c) Technical data which demonstrate conclusively that the airworthiness of the modified propeller is at least equal to that of the certificated propeller.

14.5. *Procedure relative to type certification.*—

14.50. *General.*—The procedure and general requirements for the issuance of a type certificate shall be as prescribed in CAR 01.

14.51. *Sealed drawing list.*—When a type certificate is granted, a drawing list representative of the certificated propeller is impressed with the seal of the Bureau of Air Commerce and is returned to the manufacturer. Sealed copies of the drawings may be used for this purpose in lieu of a drawing list. Bureau inspectors may call for, and must have access to, the sealed drawing list or drawings together with any other pertinent drawings when making an inspection of the manufacturer's plant to determine whether the propellers as built conform to the approved data.

14.52. *Major changes.*—Any major change from the approved drawings must be approved in advance by the Secretary. A change will be deemed major within the meaning of these regulations if it adversely affects the reliability or airworthiness of the propeller. In general, a change will be deemed major when it decreases the airworthiness of a part the failure of which might prevent the aircraft from continuing flight. In all doubtful cases the decision of the Secretary shall establish the category within which a specific change will be included.

14.520. Information accompanying a request for approval of a change to a certificated propeller shall include technical data, including (when necessary) stress analyses and reports of tests sufficient to demonstrate to the satisfaction of the Secretary that the changed propeller is airworthy. The report shall be signed and sworn to by the responsible representative of the manufacturer. If the change is to a different blade shank size, engine shaft size, blade airfoil or propeller material, application shall be made for a new type certificate.

14.53. *Minor changes.*—On January 1 and July 1 of each year the holder of a propeller type certificate shall submit, for approval and file, drawings pertaining to all the minor changes made to the propeller during the preceding 6-month period.

14.54. *Reductions in diameter.*—A type certificate may provide for reduction in diameter from that of the propeller tested, provided that no increase in rating is involved. The diameter of a propeller blade may be reduced by cutting off the tip of the blade and fairing the immediate vicinity or by telescoping the outer sections of the blade. The drawings submitted shall show the details of each blade smaller in



radius by 6-inch steps, which details may be shown superimposed on a drawing of the original blade.

#### 15. AIRCRAFT EQUIPMENT AIRWORTHINESS

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#### CHAPTER 15. AIRCRAFT EQUIPMENT AIRWORTHINESS

##### 15.0. General.—

15.00. *Provision for rating.*—Pursuant to the provisions of the Air Commerce Act requiring the Secretary of Commerce to provide for the rating of aircraft and parachutes as to their airworthiness, the requirements hereinafter set forth shall be used as a minimum basis for establishing such rating of aircraft equipment for use in certificated aircraft.

##### 15.01. *Scope of regulations.*—

15.010. These regulations shall apply to all important items of equipment which are manufactured as complete units and purchased by aircraft manufacturers and operators for use on certificated aircraft, except engines and propellers which are treated separately in CAR 13 and CAR 14 respectively.

15.011. For the purpose of these regulations an item of equipment shall be considered important if, by malfunctioning, it can endanger the safety of the aircraft, or the cargo or passengers in the aircraft, or persons or property beneath the aircraft.

15.012. Because the development of aircraft specialties is constantly increasing in scope and variety, there undoubtedly will be developed, from time to time, important items of equipment for which specific provision is not made in these regulations. In such cases the general procedure for certification will be in accordance with these regulations and the manufacturer of the item in question shall apply to the Secretary for special rulings particularly applicable to it.

15.013. The general requirements for the issuance of a type certificate are set forth in CAR 01. The procedure relative to type certification is set forth in CAR 15.05.

15.014. The requirements for the issuance of a production certificate are set forth in CAR 01.

##### 15.02. *Classification of items of equipment.*—

15.020. In view of the diversity of items of equipment and the variety of their uses, such items are herein grouped in two major classifications dependent upon the certification procedure applicable to the particular item.

15.0200. The certification procedure to be followed is similar for all items and differs only in detail in accordance with the classification within which a particular item lies.

15.0201. The specific installations in certificated aircraft of certificated items of equipment, irrespective of the classification herein used, are subject in all cases to approval by the Secretary.

15.021. It is desirable to certify a series of similar models of an item of equipment under one certification in order

to eliminate as much clerical and identification work as possible. This may be done for some types of wheels, position lights and other items, a series of which are similar in construction and differ only in size and relatively unimportant structural details. This procedure may be applied to any item to which the manufacturer can show the procedure applicable.

##### 15.022. Items of equipment are classified as follows:

(a) Items of such design that they may be installed and used in any type or model of certificated aircraft, and for which type and production certificates, as defined in CAR 01, may be issued to manufacturers.

(b) Items of such design that they are adapted to only one type or model of certificated aircraft, or of such a nature that their design necessarily varies to suit each type or model of certificated aircraft in which they may be used. Type and production certificates will not be issued for such items. They will be specially approved as integral parts of the aircraft in which they are installed.

15.023. Under CAR 15.022 (a) are included items such as the following:

- Landing gear wheels.
- Seaplane floats, excluding wing-tip floats.
- Skis, including pedestals.
- Position lights.
- Landing flares.
- Safety belts.
- Parachutes.
- Certain types of special flight and engine control units.
- Control wheels.
- Certain types of tail wheel knuckles.
- Certain types of self-locking bolts and nuts, and parts of that general character.

15.024. Under CAR 15.022 (b) are included items such as the following:

- Automatic pilots.
- De-icing equipment.
- Landing gear shock absorber units.
- Autogiro rotor hubs.
- Wing ribs.
- Fuel and oil tanks.
- Engine cowls, wheel streamlines, propeller hub spinners and other special cowlings.
- Wing-tip floats.
- Structures attaching seaplane floats to aircraft.
- Special structures attaching skis to aircraft.
- Heating and ventilating systems.

##### 15.03. *Factors affecting certification or special approval.*—

15.030. All items of equipment falling within the meaning of these regulations irrespective of their classification shall:

- (a) satisfactorily fulfill the purpose for which they are intended,
- (b) be free from undue hazard, both in themselves and in their method of operation,
- (c) be constructed of suitable and dependable materials, and
- (d) be manufactured and installed in accordance with the Civil Air Regulations so far as those regulations pertain to the particular item.

15.031. Certain of the above-mentioned factors may be demonstrated by drawings and analyses, others by drawings and tests, and others by visual inspection.

##### 15.04. *Identification data.*—

15.040. Each type or model of an item of equipment for which certification is requested shall be assigned a model name or model number by the manufacturer such that it may be distinguished from all other types or models of items of equipment.

15.041. Each unit of a certificated or specially approved type or model of equipment item shall be plainly and suitably marked to indicate that it has been certificated or spe-



cially approved. The applicable one of the following two methods shall be used to indicate this:

15.0410. (a) If a type certificate has been issued to the manufacturer for the particular item, each unit shall bear the number of this type certificate.

15.0411. (b) If a type certificate has not been issued to the manufacturer for the particular item, each unit shall bear the words "Bureau of Air Commerce Approved" or an abbreviation thereof.

15.042. Each unit of a certificated or specially approved type or model of equipment item shall bear the following identification data:

(a) Manufacturer's name.

(b) Model number or model name.

(c) The serial number or date of manufacture of the particular unit.

(d) Bureau of Air Commerce Type Certificate (or A. C. T. C.) No. -----, or Bureau of Air Commerce Approved (or A. C. A.).

(e) Such additional information as is specifically provided for in the following regulations.

15.043. The data prescribed in CAR 15.042 shall be displayed in a conspicuous place on the unit and in such a manner that it may not be easily erased, disfigured or obscured. Any other information may be added by the manufacturer at his discretion.

15.05. *Procedure relative to certification or special approval.*—

15.050. A request for certification or approval of a type or model, or when possible, of a series of similar models of an item of equipment, shall be supported by the data herein-after specified.

15.0500. A complete set of drawings descriptive of the item. Drawings of small standard commercial parts need not be submitted, but all other drawings applying to the item, including assembly drawings and, when necessary, installation drawings, shall be submitted. The drawings shall contain all dimensions and material specifications of the item. Material shall be specified by reference to a specification number of the Army, Navy, S. A. E., or other such recognized standard whenever possible. If reference is made to material specifications which are not recognized standards, complete details of such specifications shall be submitted. Revision blocks on drawings shall designate the revision by letter and shall state the nature of the revision, the date and, when serial numbers are used, the serial number of the first unit manufactured in accordance with the revision. Title blocks on drawings shall contain the date of the original issue of the drawing and the drawing number. All drawings shall be folded to a size approximately 9 by 12 inches with the title block showing. In order to eliminate a possible source of controversy, the Secretary will not accept drawings which may be altered after approval. Blueprints, photostats or their equivalent are satisfactory. These shall not contain pencil or ink notations. If certain of the drawings required for a particular model are identical with drawings previously submitted and approved in connection with a prior model made by the same manufacturer, such identical drawings need not again be submitted.

15.0501. A list, in duplicate, of all drawings applicable to the item. Such list shall include all drawings previously submitted and approved in connection with prior models made by the same manufacturer, which also apply to the model in question without change. The list shall be arranged in numerical order and shall designate each drawing by number, title, original date of issue, latest revision letter and the model designation of the item for which the drawing was previously and originally submitted if for other than the model in question. Manufacturers' parts lists, if containing the information specified herein, are acceptable as drawing lists.

15.0502. Such additional data as are hereinafter prescribed for specific cases.

15.0503. The list specified in CAR 05.0501 need not be submitted if the item for which certification is requested is

described by only one or two drawings. In such a case, however, the drawings specified in CAR 15.0500 shall be submitted in duplicate.

15.051. If the item falls within the classification covered by CAR 15.022 (a), the data submitted shall include a properly executed formal application for type certificate in accordance with CAR 01.

15.052. If the item falls within the classification covered by CAR 15.022 (b), complete information as to the make and model or makes and models of aircraft in which the item is to be installed shall be furnished. If specific aircraft are involved, the information to be furnished shall include also the serial numbers and aircraft certificate numbers of the aircraft in question.

15.053. Items of equipment which comply with the regulations herein prescribed to the satisfaction of the Secretary may be certificated or approved, as the case may be, for use in certificated aircraft.

15.054. If application for a type certificate has been made, certification is also contingent upon compliance with CAR 01 to the satisfaction of the Secretary.

15.055. Certification is subject to the provisions and restrictions stated on the type certificate and on the specification for the item issued as part of the type certificate, and approval is subject to the provisions and restrictions stated on the specification issued for the aircraft in which the item is installed.

15.056. All manufactured units of a certificated or approved item of equipment shall be in exact accordance with the approved drawings and specifications.

15.057. Changes or modifications to a certificated or approved item of equipment shall be approved by the Secretary in advance.

15.058. A request for approval of a change or modification to a certificated or approved item of equipment shall be supported by revised or new drawings showing the changes; revised drawing list pages, in duplicate, showing the revised or new drawings; and technical data, including reports of any necessary tests, sufficient to demonstrate to the satisfaction of the Secretary that the changed or modified item is airworthy.

15.06. *Previously approved items of equipment.*—These regulations supersede the requirements for approval of items of equipment set forth in previous regulations. However, items of equipment rated as suitable for use in approved aircraft in accordance with previous requirements may be used in certificated aircraft at the discretion of the Secretary.

15.1. *Landing gear equipment.*—

15.10. *Landing gear wheels.*—

15.100. Main landing gear wheels will be certificated for a maximum static load which will be determined from the strength of the wheel. Tail wheels will not be certificated.

15.1000. For the purpose of these regulations main landing gear wheels are considered as those nearest the airplane center of gravity with respect to fore-and-aft location.

15.1001. For the purpose of these regulations a tail wheel is considered as one which supports the tail of a conventional airplane in the three-point landing attitude.

15.101. For wheels other than main landing or tail wheels, application shall be made to the Secretary for special rulings particularly applicable to the cases in question.

15.102. The strength of a main landing gear wheel shall be substantiated by the following two static tests:

(a) Radial load test. (See CAR 15.1020.)

(b) Side load test. (See CAR 15.1021.)

15.1020. The required radial test load is equal to

$$(P) \times (n) \times (1.5) \times (1.25)$$

where  $P$  is the maximum static load for which approval is requested,  $n$  is

$$2.80 + \frac{9000}{2P + 4000}$$

and is the applied landing load factor for the corresponding airplane, 1.5 is the factor of safety, and 1.25 is a strength test material factor.



15.1021. The required side test load is equal to  
 $(0.35) \times (\text{the radial test load}).$

15.1022. The radial and side loads shall be applied separately and the wheel shall be equipped with the correct size tire inflated to the proper pressure for the load for which certification is requested.

15.1023. The radial load shall be applied to the wheel in the plane of the tire and may be distributed over a portion of the tire by allowing the tire to bear in a box of firm earth or sand.

15.1024. The side load shall be applied to the tire at its maximum cross-sectional width and may be distributed over an arc of not more than 60°. The wheel shall be restrained only by the axle.

15.1025. When it is impossible to apply sufficient side load to the tire due to its inability to stay on the rim of the wheel, the side load shall be applied directly to the rim of the wheel. In this case, the required test load shall be increased over that specified in CAR 15.1021 in the ratio of the distance from the center of the wheel to the point of maximum cross-sectional width of the tire, to the distance from the center of the wheel to the point where the load actually is applied, thus obtaining a bending moment at the center of the wheel of the same value as would have been obtained had the load been applied at the maximum cross-sectional width of the tire.

15.103. A main landing gear wheel shall support the required loads before failure.

15.104. When a brake is incorporated in a main landing gear wheel, the brake mechanism and its operation shall be satisfactory to the Secretary and the brake shall be free from any undue tendency to lock or jam.

15.105. The rim contour of a main landing gear wheel shall conform to the Tire and Rim Association's standards or recommendations unless the wheel is to be used in conjunction with a specially constructed tire.

15.106. A landing gear wheel may be equipped with any make or type of tire, provided that the tire is a proper fit on the rim of the wheel and provided that the tire manufacturer's load rating, which he uses and recommends as a basis for his guarantee, is not exceeded.

15.107. Each unit of a certificated model of main landing gear wheel shall bear the following additional identification data as prescribed in CAR 15.042 (e):

The maximum static load for which certificated.

15.108. A request for certification of a type or model or series of models of main landing gear wheels shall be supported by the following additional data as prescribed in CAR 15.0502:

15.1080. A report of the static tests prescribed in CAR 15.102. The report shall contain complete details of the tests, including records of wheel deflections and photographs of the test setups. If the side load is applied in accordance with CAR 15.1025, the report shall show clearly that the procedure prescribed in CAR 15.1024 was impossible. The report shall be signed by the person making the tests, and shall be supported by affidavit unless the tests were witnessed by a Bureau inspector, in which case such inspector also will sign the report as a witness.

#### 15.11. Seaplane floats.—

15.110. Main seaplane floats will be certificated for a maximum gross weight of airplane which will be determined in accordance with the applicable requirements prescribed in CAR 04.

15.1100. Certification of a float does not include certification of the structure attaching it to the aircraft. Such structure is classified in accordance with CAR 15.022 (b).

15.1101. The installation of floats on aircraft shall be in accordance with the provisions of CAR 04.

15.111. Each unit of a certificated model of main seaplane float shall bear the following additional identification data as prescribed in CAR 15.042 (e):

(a) The maximum gross weight of aircraft for which certificated.

(b) The number of floats per aircraft.

15.112. A request for certification of a type or model or series of models of main seaplane floats shall be supported by the following additional data as prescribed in CAR 15.0502:

15.1120. The technical data required to prove compliance with the applicable structural and detail design requirements prescribed in CAR 04.

#### 15.12. Skis.—

15.120. Skis, including ski pedestals, will be certificated for a maximum static load which will be determined from the strength of the ski.

15.1200. Certification of a ski and its pedestal does not include certification of any special structure attaching it to the aircraft. Such structure is classified in accordance with CAR 15.022 (b).

15.1201. The installation of skis on aircraft shall be in accordance with the provisions of CAR 04.

15.121. The strength of a ski, including the pedestal, shall be substantiated by a stress analysis or by static tests.

15.122. A ski, including the pedestal, shall be designed to carry the following loads without failure when supported at the pedestal bearing sleeve:

15.1220. A load upward, distributed uniformly along the ski bottom and symmetrically with respect to the pedestal bearing sleeve in the fore-and-aft direction, the front end of the ski carrying no load if it is at a greater distance from the bearing sleeve than the rear end. The required load is equal to

$$(P) \times (n) \times (1.5)$$

where  $P$  is the maximum static load for which approval is requested,  $n$  is

$$2.80 + \frac{9000}{2P + 4000}$$

and is the applied landing load factor for the corresponding airplane, and 1.5 is the factor of safety. If the strength is substantiated by static test, the required test load is equal to

$$(P) \times (n) \times (1.5) \times (1.25)$$

where 1.25 is a strength test material factor.

15.1221. A load upward, applied to the ski bottom at a point directly under the pedestal bearing sleeve. The required load, or required test load, is equal to the load, or test load, specified in CAR 15.1220.

15.1222. A side load distributed uniformly along the edge of the ski bottom and symmetrically with respect to the pedestal bearing sleeve in the fore-and-aft direction, the front end of the ski carrying no load if it is at a greater distance from the bearing sleeve than the rear end. The required load, or required test load, is equal to 35 per cent of the load, or test load, specified in CAR 15.1220. When the height of the aircraft axle from the ground with the ski installed is greater than that with the interchangeable wheel installed, such side load shall be reduced by the ratio of the height of the axle from the ground with the interchangeable wheel installed, to the height of the axle from the ground with the ski installed.

15.1223. A side load applied to the edge of the ski bottom at a point near the front end of the ski. The required load, or required test load, is that necessary to produce a bending moment on the aircraft axle in a horizontal plane of the same magnitude as the bending moment in the vertical plane produced by the load, or test load, specified in CAR 15.1222.



15.123. Each unit of a certificated model ski shall bear the following additional identification data as prescribed in CAR 15.042 (e):

15.1230. The maximum static load for which certificated.

15.124. A request for certification of a type or model or series of models of skis shall be supported by the following additional data as prescribed in CAR 15.0502:

15.1240 (a). A stress analysis of the ski and pedestal showing compliance with CAR 15.122, if the strength of the ski and pedestal has been substantiated by a stress analysis. Such analysis shall be signed by the responsible engineer.

15.1241 (b). A report of the static tests showing compliance with CAR 15.122, if the strength of the ski and pedestal has been substantiated by static tests. The report shall contain complete load computations, complete details of the tests, and photographs of the test setups. The report shall be signed by the person making the tests and shall be supported by affidavit unless the tests were witnessed by a Bureau inspector, in which case such inspector also will sign the report as a witness.

## 15.2. Navigation equipment.—

### 15.20. Position lights.—

15.200. Position lights prescribed in CAR 04, in order to be certificated, shall be so constructed and capable of being so mounted as to comply with the regulations hereinafter prescribed.

15.2000. The installation of position lights in aircraft shall be in accordance with the applicable provisions of CAR 04 to CAR 08 inclusive, and the light manufacturer's mounting instructions.

15.201. As the forward (right and left wing) lights are complementary they will be certificated as a unit. The rear (tail) light will be certificated as a separate unit.

15.202. Forward lights are classified as follows:

- (a) Standard forward position lights.
- (b) Airline forward position lights.
- (c) Auxiliary position lights.

15.203. *Angular limits.*—Position lights shall be so designed as to show unbroken light within the limits hereinafter specified.

15.2030. Each standard and airline forward light shall show an unbroken light between two vertical planes whose dihedral angle is 110 degrees, measured to the left from dead ahead for the left light and correspondingly to the right from dead ahead for the right light. In all directions outside of these limits an additional tolerance of not more than 10 degrees will be permitted within which the cut-off from the required intensity to the permissible stray-light intensity, specified in CAR 15.2040 and CAR 15.2041, shall be effected.

15.2031. Each auxiliary light shall show an unbroken light between the vertical plane through the longitudinal axis forward and a conical surface generated by a line making an angle of 20 degrees with the longitudinal axis forward, measured to the left from dead ahead for the left light and correspondingly to the right from dead ahead for the right light. Outside of these limits the cut-off shall be effected within the limits, including tolerance angle, prescribed for the standard and airline forward position lights.

15.2032. The rear light shall show to the rear an unbroken light between two vertical planes whose dihedral angle is 140 degrees, of which 70 degrees lies on either side of dead aft. In all directions outside of these limits an additional tolerance of not more than 10 degrees will be permitted within which the cut-off from the required intensity to the permissible stray-light intensity, specified in CAR 15.2043, shall be effected.

15.204. *Light Intensity.*—Position lights shall be so designed as to provide the light intensities hereinafter specified when equipped with the lamps prescribed by the manufacturer operated at the candlepower or current rating publicly established by the lamp manufacturer.

15.2040. Each standard forward light shall have an intensity of not less than 8 candlepower in all directions within 30 degrees of the longitudinal axis forward, subject to the limits specified in CAR 15.2030. Each light shall have an intensity of not less than 4 candlepower in all directions between 30 degrees and 90 degrees of the longitudinal axis forward, subject to the limits specified in CAR 15.2030. Each light shall have an intensity of not less than 3 candlepower in all other directions within the limits specified in CAR 15.2030. No light shall have a stray-light intensity of more than 1 candlepower in any direction outside of the specified limits, except within the permissible tolerances specified in CAR 15.2030.

15.2041. Each airline forward light shall have an intensity of not less than 35 candlepower in all directions within 20 degrees of the longitudinal axis forward, subject to the limits specified in CAR 15.2030. Each light shall have an intensity of not less than 8 candlepower in all directions between 20 degrees and 30 degrees of the longitudinal axis forward, subject to the limits specified in CAR 15.2030. Each light shall have an intensity of not less than 4 candlepower in all directions between 30 degrees and 90 degrees of the longitudinal axis forward, subject to the limits specified in CAR 15.2030. Each light shall have an intensity of not less than 3 candlepower in all other directions within the limits specified in CAR 15.2030. No light shall have a stray-light intensity of more than 1 candlepower in any direction outside of the specified limits, except within the permissible tolerances specified in CAR 15.2030.

15.2042. Each auxiliary light shall have an intensity of not less than 35 candlepower in all directions within 20 degrees of the longitudinal axis forward, subject to the limits specified in CAR 15.2031. No light shall have a stray-light intensity of more than 1 candlepower in any direction outside of the specified limits, except within the permissible tolerances specified in CAR 15.2031.

15.2043. The rear light shall have an intensity of not less than 8 candlepower in all directions within 70 degrees of the longitudinal axis aft, subject to the limits specified in CAR 15.2032. The light shall have an intensity of not less than 4 candlepower in all other directions within the limits specified in CAR 15.2032. The light shall not have a stray-light intensity of more than 1 candlepower in any direction outside of the specified limits, except within the permissible tolerances specified in CAR 15.2032.

15.205. *Color.*—All left wing lights shall be aviation red, all right wing lights shall be aviation green, and all rear lights shall be aviation white. These colors are defined in CAR 31.

15.206. *Light covers.*—The light bulbs shall be protected by a cover which shall be of noncombustible material and so constructed that it will not change color, or cloud, or suffer any considerable loss of transmission in use. The coloring of colored portions shall be completely diffused through the material.

15.207. A request for certification of a type or model or series of models of forward position lights or rear position lights shall be supported by the following additional data as prescribed in CAR 15.0502:

15.2070. A copy of the instructions for the mounting of the lights in aircraft, furnished by the manufacturer to purchasers of the lights.

15.208. A request for certification and its supporting data shall be accompanied by a complete set of lights described in the data. These lights will be tested at the Department of Commerce laboratory for compliance with CAR 15.203 to CAR 15.206 inclusive.

## 15.21. Landing flares.—

15.210. Landing flares prescribed in CAR 04, in order to be certificated, shall be so constructed and capable of being so mounted as to comply with the regulations hereinafter prescribed.



15.2100. The installation of landing flares in aircraft shall be in accordance with the provisions of CAR 04 to CAR 08 inclusive, and the flare manufacturer's mounting instructions.

15.211. Landing flares will be certificated with respect to their light duration and light intensity. They are grouped in three classifications as follows:

- (a) Class 1 flares.
- (b) Class 2 flares.
- (c) Class 3 flares.

15.212. Class 1 flares shall have a light duration of at least 3 minutes, a light intensity of at least 200,000 candlepower and a rate of descent not greater than 550 feet per minute.

15.213. Class 2 flares shall have a light duration of at least 1½ minutes, a light intensity of at least 110,000 candlepower and a rate of descent not greater than 550 feet per minute.

15.214. Class 3 flares shall have a light duration of at least 1 minute, a light intensity of at least 70,000 candlepower and a rate of descent not greater than 550 feet per minute.

15.215. Each unit of a certificated model landing flare shall bear the following additional identification data as prescribed in CAR 15.042 (e):

15.2150. The class for which certificated.

15.216. A request and supporting data for certification of a type or model or series of models of a landing flare shall be accompanied by 2 flares of each model described in the data. These flares will be tested at the Department of Commerce laboratory for compliance with the light duration and intensity requirements specified in CAR 15.212, CAR 15.213 or CAR 15.214, as the case may be.

15.217. Upon satisfactory completion of the examination of the technical data submitted to the Department of Commerce and satisfactory completion of the tests of the flares submitted to the Department of Commerce, 5 flares of each model described in the data, an airplane arranged for the complete installation of flares of each model, and operating personnel shall be made available for functional tests of the flares. These tests may be made at any location desired by the manufacturer.

15.2170. In the event that there is one failure out of the 5 flares subjected to functional tests, 5 additional flares shall be subjected to functional tests.

15.2171. Failure of two or more flares out of 10 dropped shall be sufficient grounds for denial of certification by the Secretary. Certification will be made only if all 5 original flares function satisfactorily or, in the event of one failure in the original 5, if the second 5 function satisfactorily.

#### 15.3. Safety equipment.—

##### 15.30. Safety belts.—

15.300. Safety belts will be certificated for general aircraft use or for glider use dependent upon the strength of the belt.

15.3000. Certification of a safety belt does not include certification of its anchorages to the aircraft.

15.3001. The installation of safety belts in certificated aircraft shall be in accordance with the pertinent provisions of CAR 04.

15.301. Safety belts shall be so designed as to be easily adjustable. Each belt shall be equipped with a quick-release mechanism so designed that it cannot be released inadvertently. The width of a certificated safety belt shall be at least 2 inches.

15.302. The strength of a safety belt shall be determined by static test.

15.303. Safety belts for general aircraft use will be certificated for one person or two adjacent persons dependent upon the strength of the belt.

15.3030. A safety belt for one person shall be capable of withstanding a load of 1,000 pounds applied in the same manner as a person's weight would be applied in a crash. The quick-release mechanism shall be capable of withstanding this load without undue distortion, so that when the load is relieved to 400 pounds, the mechanism shall be capable of being operated by hand.

15.3031. A safety belt for two persons shall be capable of withstanding a load of 2,000 pounds applied in the same

manner as the weight of two persons would be applied in a crash. The quick-release mechanism shall be capable of withstanding this load without undue distortion, and when the load is relieved to 800 pounds, the mechanism shall be capable of being operated by hand.

15.304. Safety belts for glider use only will be certificated as such.

15.3040. A safety belt for glider use shall be capable of withstanding a load of 850 pounds applied in the same manner as a person's weight would be applied in a crash. The quick-release mechanism shall be capable of withstanding this load without undue distortion, and when the load is relieved to 400 pounds, the mechanism shall be capable of being operated by hand.

15.305. Each unit of a certificated model safety belt shall bear the following additional identification data as prescribed in CAR 15.042 (e):

15.3050. Whether for one person, two persons, and/or for glider use only.

15.306. A request for certification of a type or model or series of models of safety belts shall be supported by the following additional data as prescribed in CAR 15.0502:

A report of the static tests showing compliance with CAR 15.3030, CAR 15.3031 or CAR 15.3040, as the case may be. The report shall contain complete details of the tests, including the hand operation of the quick-release mechanism under relieved load, and shall contain photographs of the test setup. The report shall be signed by the person making the tests and shall be supported by affidavit unless the tests were witnessed by a Bureau inspector, in which case such inspector also will sign the report as a witness.

#### 15.31. Parachutes.—

15.310. Parachutes prescribed by CAR 60, in order to be certificated, shall be so constructed as to comply with the following regulations.

15.3100. All materials used shall be equivalent to or better than those specified by the United States Army or Navy for parachutes, or shall be proved satisfactory to the Secretary by technical data and practical tests.

15.3101. The follow through between parachute and rider shall be so engineered that all parts or fittings carrying a shock load are stronger than the combined strength of the suspension lines to which they are attached.

15.3102. All metal parts shall be designed to carry their full rated load without yielding.

15.3103. The fabric used in the canopy construction shall be free from gums, starches and other foreign material. It shall also be free from avoidable imperfections in manufacture and from defects or blemishes affecting its strength or durability and shall have been finished without application of excessive heat. The surface of the fabric shall be smooth.

15.3104. Suspension lines shall be continuous, without splices, from connector link to connector link and shall contain no knots between these points.

15.3105. Before securing the suspension lines to the skirt, each line shall be put under 40 pounds tension and marked to show the point of attachment. The fabric shall be pulled out but not stretched.

15.3106. The machine sewing shall be made with a shuttle or plain stitch. All zigzag sewing shall be done on a 2-stitch zigzag sewing machine.

15.3107. The rip cord, including joints between the handle and the release, shall be designed to withstand a load of 300 pounds.

15.3108. The harness shall be so constructed that the rider can release himself and drop clear in case of a water landing, but a quick-attachable or quick-releasing device between the harness and the parachute is not mandatory.

15.3109. Each parachute outfit shall be provided with a suitable place for keeping a record card containing spaces for recording dates of repacking, repairs, by whom made and space for the manufacturer's recommendations as to repacking.

15.311. Deviations from CAR 15.3104, CAR 15.3105 and CAR 15.3106 shall be such as are acceptable to the United



States Army or Navy, or shall be proved satisfactory to the Secretary by technical data and practical tests.

15.312. A request for certification of a type or model or series of models of parachutes shall be supported by the following additional data as prescribed in CAR 15.0502:

15.3120 (a). Data showing compliance with CAR 15.3100 to CAR 15.3109 inclusive. These data may be references to drawings submitted if the drawings clearly show compliance with these regulations.

15.3121 (b). Data substantiating any deviations in accordance with CAR 15.311.

15.3122 (c). A detailed list of the material and strength specifications of all component parts of the parachutes described in the drawings. The list shall also specify the manufacturing practices employed in the assembly operations and shall satisfy the Secretary that all parts are properly pull-tested before assembly.

15.313. Upon satisfactory completion of the examination of the technical data submitted to the Department of Commerce, parachutes of each model described in the data together with an airplane and operating personnel shall be made available for the following tests of the parachutes. These tests may be made at any location desired by the manufacturer.

15.3130. *Functional test (normal pack)*.—12 drops from an airplane with a 170 pound dummy man, from an altitude of not more than 500 feet. The indicated air speed of the airplane at the time of release shall be 100 miles per hour. No twists shall purposely be packed in the suspension lines. The parachute must be fully open within 3 seconds from time of release.

15.3131. *Functional test (twisted lines)*.—5 drops from an airplane with a 170 pound dummy man, from an altitude of not more than 500 feet. The indicated air speed of the airplane at the time of release shall be 100 miles per hour. 3 twists shall purposely be packed in the suspension lines near the skirt. The parachute must be fully open within 4 seconds from time of release.

15.3132. *Strength test*.—3 drops with the same parachute from an airplane with a 600 pound lead weight, from an altitude of not more than 500 feet. The indicated air speed of the airplane at the time of release shall be 100 miles per hour. No twists shall purposely be packed in the suspension lines. The weight shall be attached to the harness. No external shock absorbers or material which may act as such shall be permitted. The parachute shall show no failure of any material.

15.3133. *Live drop test*.—2 live drops from an airplane with a 170 pound man, from an altitude of 2,000 feet on a comparatively still day. An additional certificated auxiliary parachute shall be carried. The rider must suffer no discomfort from opening shock and must be able to disengage himself from the harness after landing.

15.3134. *Rate of descent test*.—One drop from an airplane with a 170 pound dummy man, from an altitude of 2,500 feet. The rate of descent shall not exceed 21 feet per second. The descent shall be timed from the time of full opening to the time of ground impact. The distance descended shall be assumed at 2,250 feet and the rate of descent shall be this distance divided by the time in seconds.

15.3135. 100 per cent performance shall be required in the tests specified in CAR 15.3130 through CAR 15.3134 except in the case of an auxiliary parachute. (See CAR 15.315.)

15.314. The tests specified in CAR 15.313 will not be required for parachutes previously approved by the United States Army Air Corps or by the Bureau of Aeronautics, Navy Department. In lieu of these tests, there shall be included in the supporting data submitted with a request for certification of such a parachute the following data:

15.3140 (a). A copy of the official report describing the drop tests and static tests which formed the basis of the Army or Navy approval, signed by the Army or Navy representatives who witnessed the tests.

15.3141 (b). A statement by an authorized representative of the Army or Navy to the effect that the parachute is

approved and accepted by the Army or Navy as the case may be.

15.315. A parachute to be certificated for use as an auxiliary parachute in combination with a certificated parachute, need not comply with the rate of descent specified in CAR 15.3134 but shall have a rate of descent not exceeding 25 feet per second and shall comply with all of the other regulations herein prescribed.

15.3150. The technical data submitted in connection with an auxiliary parachute and the tests made to obtain its certification shall satisfactorily account for the combination of parachutes and not the auxiliary parachute alone.

15.3151. Each unit of a certificated model auxiliary parachute shall bear the following additional identification data as prescribed in CAR 15.042 (e): "Auxiliary Only."

#### 15.4. Control and structural units.—

##### 15.40. General.—

15.400. Certain types of special control units and structural units, such as those listed in CAR 15.023, so designed that they can be used in any type or model of aircraft without change or with only minor changes which in no way affect the operation or strength of the units, will be certificated provided that they comply with the regulations applicable to them prescribed in CAR 04 to CAR 08 inclusive.

15.4000. The installation of such special units in aircraft shall be in accordance with the pertinent provisions of CAR 04 through CAR 08 inclusive and the instructions of the manufacturers of the units.

15.401. Before requesting certification of a type or model or series of models of a special control unit or structural unit, the manufacturer shall apply to the Secretary for a ruling as to the additional data to be submitted in accordance with CAR 15.0502 to show compliance with the regulations applicable to the unit in question prescribed in CAR 04 through CAR 08. This application shall be accompanied by a description of the unit and a drawing, or drawings, sufficient to enable the Secretary to make a ruling particularly applicable to the unit in question.

##### 15.5.

##### 15.6.

##### 15.7.

15.8. *Equipment items adapted to specific aircraft models*.—

15.80. *Equipment items adapted to only one aircraft model*.—

15.800. Certain items of equipment, such as those listed in CAR 15.024, so designed that they can be used only in one aircraft model will be specially approved as integral parts of the aircraft in which they are installed provided that they comply with the regulations applicable to them prescribed in CAR 04 through CAR 08.

15.801. A request for approval of such an item of equipment shall be supported by the following additional data as prescribed in CAR 15.0502:

15.8010. (a) Data showing compliance with the regulations applicable to the item in question prescribed in CAR 04 to CAR 08 inclusive.

15.8011. (b). In lieu of the data specified in CAR 15.801 (a), data in accordance with a special ruling made by the Secretary and obtained by the procedure prescribed in CAR 15.401.

15.802. The request for approval of such an item of equipment together with its supporting data shall be included with the approval request and supporting data for the aircraft model in which the item is installed.

15.81. *Equipment items adapted to any aircraft model by means of detail design changes*.—

15.810. Certain items of equipment, such as those listed in CAR 15.024, of such a nature that by means of detail design changes they can be used in any aircraft model, will be specially approved as integral parts of the aircraft in which they are installed provided that they comply with the regulations applicable to them prescribed in CAR 04 through CAR 08.

15.811. If the manufacturer so desires, such an item of equipment may be considered as a series of items, each so



designed that it can be used only in one aircraft model. Approval in such a case will be handled as prescribed in CAR 15.80.

15.812. If the procedure prescribed in CAR 15.811 is too cumbersome to suit a particular item, the item will be considered in two parts as follows:

- (a) The unchanged basic structure.
- (b) The variable structure.

15.813. If the basic structure is deemed satisfactory by the Secretary, only the variable structure need be considered in connection with the certification of each aircraft model in which the item is installed.

15.814. A request for examination of the basic structure of such an item of equipment shall be supported by the following additional data as prescribed in CAR 15.0502:

15.8140 (a). Data showing compliance with the regulations applicable to the item in question prescribed in CAR 04 through CAR 08.

15.8141 (b). In lieu of the data specified in CAR 15.814 (a), data in accordance with a special ruling made by the Secretary and obtained by the procedure prescribed in CAR 15.401.

15.815. A request for approval of a complete item of equipment in this classification shall be supported by the following data:

15.8150 (a). Complete references to the data pertaining to the basic structure previously deemed satisfactory by the Secretary.

15.8151 (b). Data as prescribed in CAR 15.814 (a) or CAR 15.814 (b), but pertaining only to the variable structure.

15.8152 (c). Any additional data which may have been prescribed by the Secretary at the time of his examination of the basic structure.

#### 18. REPAIR AND ALTERATION OF AIRCRAFT

18.0 Provision for Re-Rating

18.1 Types of Repair

18.2 Types of Alteration

18.3 Types of Repair Agency

18.4 Rules Governing Repair Agencies

18.5 Procedure Governing Repairs

18.6 Procedure Governing Alterations

18.7 Technique and Practices

#### CHAPTER 18. REPAIR AND ALTERATION OF AIRCRAFT

18.0. *Provision for re-rating.*—Pursuant to the provisions of the Air Commerce Act requiring the Secretary of Commerce to provide for the re-rating of aircraft as to their airworthiness, a certificated aircraft, or component thereof, which has been altered or repaired may be re-rated as to airworthiness in accordance with such of the following provisions as may be applicable.

18.1. *Types of repair.*—An aircraft will be deemed to have been repaired when

18.10. (a). any non-structural member (such as a fairing, cowl or turtleback; 5 per cent or less of the surface of a fabric covered wing or control surface; not more than two adjacent wing or control surface ribs; and the trailing edge of a wing or control surface) has been repaired, or when a complete structural component (such as a wing panel; a landing gear; a wheel; a landing gear, wing or control surface strut; and a control surface) has been replaced by one purchased from the original manufacturer, in which cases the repair will be designated as a minor repair, or when

18.11 (b). any structural member (such as a spar; a wing or control surface leading edge or tip strip; a control surface rib; three or more adjacent wing ribs; a wing or cabane strut wire; a wing compression member; a fitting; a landing gear or tail surface strut or wire; a fuselage longeron, cross tube, diagonal or bulkhead; any portion of the wooden or metal cover of a stressed-skin wing, control surface, fuselage or landing gear; and any bracket supporting a seat, baggage compartment, fixed equipment or control system part) has been repaired or replaced, in which case the repair will be designated as a major repair, or when

18.12 (c). the engine has been overhauled, or when

18.13 (d). the propeller has been repaired, or when

18.14 (e). an instrument has been repaired.

18.2. *Types of alteration.*—An aircraft will be deemed to have been altered when

18.20 (a). the aircraft structure has been changed, except in a manner which incorporates the use of a member or a portion of a member of greater strength than the original member in accordance with Bureau of Air Commerce Manual (ACM 18), or when

18.21 (b). any change has been made in the engine, propeller, equipment or arrangement of equipment, which change may affect the balance, stability, local strength of supporting structures, or any other aspect of the airworthiness of the aircraft, or when

18.22 (c). the engine has been altered, or when

18.23 (d). the propeller has been altered.

18.3. *Types of repair agency.*—Agencies which alter or repair an aircraft in accordance with the classifications set forth in CAR 18.1 and CAR 18.2 will be classified as follows:

18.30. *Manufacturer.*—means the manufacturer holding a type certificate for the construction of the aircraft, engine or propeller which is being altered, repaired or overhauled; or the manufacturer of the instrument being repaired.

18.31. *Certificated repair station.*—means a repair station engaged in altering, repairing or overhauling an aircraft, engine, propeller or instrument in accordance with the classification for which it has been approved as provided for in CAR 52.

18.310. An airplane manufacturer, upon application, shall be eligible for a certificate of competency to operate a repair station in the classification covering the same type of structure as employed in the aircraft for which he holds a type certificate.

18.311. A manufacturer holding a type certificate for an engine, upon application, shall be eligible for a certificate of competency to operate a repair station certificated for engine overhaul.

18.312. A propeller manufacturer, upon application, shall be eligible for a certificate of competency to operate a repair station in the classification covering the same type of propeller as that for which he holds a type certificate.

18.32. *Other agency.*—means a certificated airplane or engine mechanic, i. e., one holding a certificate of competency as provided for in CAR 23, not employed by a manufacturer as defined in CAR 18.30 or by a repair station as defined in 18.31.

18.4. *Rules governing repair agencies.*—Repair agencies as designated in CAR 18.30, 18.31, and 18.32 shall be governed by the following rules:

18.40. The alteration or repair of a structural component of a certificated aircraft shall be made by the manufacturer of the aircraft or made by, or continuously supervised by, a certificated airplane mechanic only.

18.41. The alteration or overhaul of a certificated engine shall be made by the manufacturer of the engine or made by, or continuously supervised by, a certificated airplane or engine mechanic only.

18.42. The alteration, overhaul or repair of a certificated propeller shall be made by the manufacturer of the propeller or made by, or continuously supervised by, a certificated airplane or engine mechanic only.

18.43. An agency as defined in CAR 18.32 shall not engage in the alteration of a certificated engine, or in the alteration, overhaul or repair of a certificated propeller, or in the repair or overhaul of an instrument with which a certificated airplane is equipped.

18.44. Any agency engaged in the overhaul or repair of a certificated engine shall use only structural engine parts which are deemed satisfactory by the Secretary.

18.45. When an engine part or a propeller part is rejected in accordance with these regulations, a copy of the notice of rejection shall be forwarded to the Bureau of Air Commerce.



18.46. When an entry as to any alteration or repair is made in a log-book as required by these regulations, such entry shall include the signature, and title or mechanic certificate number, of the person making such entry.

18.5. *Procedure governing repairs.*—

18.50. *Major repairs.*—Any repair agency engaged in the major repair of a certificated aircraft shall execute Repair and Alteration Form AC 18-1 in duplicate.

18.500. The repair agency shall accurately list the location and the nature of the repair on the blank pages of the form. It shall incorporate in the form such technical data as are necessary to substantiate the airworthiness of the repair, either by reference to the figures and tables in ACM 18, or by the incorporation of computations and well dimensioned detail sketches, or by both. When such data are too extensive, they shall be appended to the original copy of the form and reference thereto shall be made in both copies of the form.

18.501. The repair agency shall request a designated inspector of the Bureau to examine the form, the data and the repair.

18.502. The original parts removed from an aircraft in making a major repair or replacement shall be retained for comparison by such inspector.

18.503. The repair or replacement will be approved when comparison with the retained part indicates conformity with the original, but such inspector may, at his discretion, require that he be furnished a drawing from the original manufacturer of the part or parts in question, or that the agency make a drawing of the part or parts in question and have the drawing approved, in writing, by the manufacturer.

18.504. An invoice is not acceptable as proof of conformity of a purchased replacement with approved specifications therefor, except when such invoice is issued by the original manufacturer.

18.505. Such inspector may require that he be furnished with a sample or samples of the material or materials used in making a major repair or replacement. When it is not possible to compare the materials by a visual inspection the results of material specification tests of the original and replacement samples shall be supplied.

18.506. Such inspector shall determine whether or not the workmanship and materials are in accordance with the regulations and accepted practice.

18.507. Provided such inspector deems the repair airworthy, he will issue a temporary airworthiness certificate.

18.508. The owner shall incorporate the duplicate copy of Form AC 18-1 in the aircraft log-book.

18.51. *Minor repair.*—A repair agency engaged in the minor repair of a certificated aircraft shall make a detailed entry descriptive thereof in the aircraft log-book. If replacement of a component purchased from the original manufacturer is involved, the entry shall so state.

18.52. *Engine overhaul.*—A repair agency engaged in the overhaul of a certificated engine shall make a detailed entry descriptive thereof in the engine log-book.

18.53. *Propeller repair or overhaul.*—Only agencies as defined in CAR 18.30 and 18.31 may repair or overhaul a certificated propeller.

18.530. When a propeller has been repaired, the agency shall execute one copy of Repair and Alteration Form AC 18-1 and deliver it to the owner who shall incorporate it in the aircraft log-book.

18.54. *Instrument repair.*—Any agency as defined in CAR 18.30, 18.31 or 18.32 may repair an instrument with which a certificated aircraft is equipped, except that an agency as defined in CAR 18.32 shall not repair an instrument with which a certificated airline aircraft is equipped.

18.540. When an instrument with which a certificated airline aircraft is equipped has been repaired, the agency or owner shall make an entry thereof in the aircraft log-book and the owner shall be responsible for the making of such entry.

18.6. *Procedure governing alterations.*—

18.60. *Aircraft alteration.*—A repair agency engaged in the alteration of a certificated aircraft shall execute Repair and Alteration Form AC 18-1 in duplicate.

18.600. The repair agency shall accurately list the location and the nature of the alteration on the blank pages of the form. It shall incorporate in the form such drawings, well-dimensioned detail sketches, stress analyses and balance computations as are necessary to substantiate the airworthiness of the alteration. When such data are too extensive, they shall be appended to the original copy of the form and reference thereto shall be made in both copies of the form.

18.601. The repair agency shall request a designated inspector of the Bureau to examine the form, the data and the alteration.

18.602. Such inspector may, at his discretion, deem the alteration airworthy or request the agency to submit the original copy of the form together with the data to the Bureau.

18.603. If such inspector deems the alteration airworthy, he will issue a temporary airworthiness certificate and deliver the duplicate copy of the form to the agency or the owner for incorporation in the appropriate log-book.

18.604. If such inspector requests the agency to refer the decision to the Bureau, the alteration will be examined and either

18.6040 (a). deemed airworthy, in which case the form and the data will be transmitted to the supervising inspector of the district involved, together with an authorization to proceed with such inspection as may be considered necessary, or

18.6041 (b). deemed unairworthy, in which case the agency will be so notified.

18.605. If the inspection provided for in CAR 18.6040 is satisfactory, such inspector will proceed as provided in CAR 18.603.

18.61. *Engine alteration.*—Only agencies as defined in CAR 18.30 and 18.31 may engage in the alteration of a certificated engine.

18.610. A repair agency engaged in the alteration of a certificated engine shall execute Repair and Alteration Form AC 18-1 in duplicate.

18.611. The repair agency shall accurately list the nature of the alteration on the blank pages of the form. It shall incorporate in the form such drawings, well-dimensioned detail sketches, stress analyses and test reports as are necessary to substantiate the airworthiness of the alteration. When such data are too extensive, they shall be appended to the original copy of the form and reference thereto shall be made in both copies of the form.

18.612. The repair agency shall submit the original copy of the form together with the data to the Bureau for examination.

18.613. Upon examination of the form and data, the Bureau may approve the alteration and so notify the agency, in which case the agency shall deliver the duplicate executed copy of the form to the owner who shall incorporate it in the engine log-book; or it may deem an inspection necessary, in which case it will transmit the form and the data to the supervising inspector of the district involved, together with authorization to proceed with such inspection as may be deemed necessary.

18.614. If the inspection provided for in CAR 18.613 is satisfactory, the agency will deliver the duplicate executed copy of the form to the owner who shall incorporate it in the engine log-book.

18.62. *Propeller alteration.*—The provisions in CAR 18.61 through 18.614 for the alteration of a certificated engine are applicable likewise in the case of alteration of a certificated propeller, except that the duplicate executed copy of the form shall be incorporated in the aircraft log-book by the owner.

18.7. *Technique and practices.*—

18.700. *Materials.*—The use of materials of inferior quality or of those which experience has shown to lack uniformity



of quality or strength shall be regarded as sufficient cause for withholding approval of alterations and repairs to certificated aircraft.

18.7000. The important physical properties of the materials used shall be definitely specified in the form or accompanying data, either by reference to an accepted standard such as Army, Navy, or S. A. E. specifications or by reference to reliable test results.

18.7001. Only the highest quality of casein or animal glue shall be used in making alterations or repairs to wood parts in certificated aircraft.

18.701. *Aluminum alloy structures.*—

18.7010. All aluminum alloy rivets used by repair agencies shall be properly heat-treated, driven within proper time limits, and of proper materials to insure suitable rivet strength, except in approved special cases in secondary parts where the rivets do not transmit stress, in which cases no heat treatment is necessary, and except in cases when the repair agency has drawings of the manufacturer which show that unheat-treated rivets are satisfactory. Special care shall be taken in the heat treatment of rivets to insure that individual rivets are actually rapidly quenched in the quenching medium.

18.7011. Bolts, screws and rivets employed in joints of dissimilar metals and of wood to aluminum alloy members, in addition to being properly heat-treated, shall be specially coated with paint just prior to assembly. (This is particularly important in the case where an aluminum bolt or screw passes through or into wood, or where bolts or rivets pass through tubing.) In structures made entirely from Alclad materials, bare bolts may be used.

18.7012. The following practices are hereby prohibited:

18.70120 (a). Quenching of 17S or 24S alloys in hot water or air after heat treatment.

18.70121 (b). Insufficiently rapid transfer of 17S or 24S alloys from the heat treatment medium to the quench tank. (An elapsed time of 10 or 15 seconds will, in many cases, result in noticeably impaired corrosion resistance.)

18.70122 (c). Painting after assembly, without prior protective treatment, of non-Alclad structures which are to be subjected to severe corrosive conditions. Whenever possible, parts which are not made from Alclad materials shall be anodized and shop primed prior to assembly.

18.70123 (d). Intimate contact of dissimilar metals or of wood with aluminum alloys.

18.70124 (e). Use of wood which is not thoroughly moisture-proofed for assembly into aluminum alloy structures.

18.70125 (f). Re-heating at temperatures above that of boiling water of 17S or 24S alloys after heat treatment, and the baking of primers at temperatures above that of boiling water.

18.70126 (g). The use of annealed 17S or 24S alloys in parts subject to severe corrosive conditions.

18.70127 (h). The use of hygroscopic materials improperly moisture-proofed in attempting to affect water-tightness of joints and seams.

18.70128 (i). The use of paint removers which contain strong caustic compounds, and of thin paint removers which may have a tendency to run into joints, rather than of those which have a jelly-like consistency.

18.70129 (j). The leaving of any trace of welding flux immediately after welding. (This is most readily prevented by washing in a warm 5% solution of sulphuric acid, rinsing in clear warm water, scrubbing accessible welds with a stiff-bristled brush, and giving a final rinse in clear warm water.)

18.7013. Gasoline tanks with inaccessible interior welds shall be immersed in a tank containing warm 5% sulphuric acid, agitated while rinsing in clear warm water, and then dried.

18.702. *Heat treatment.*—Before replacing damaged members with replacements not purchased from the original manufacturer of the aircraft, the repair agency shall in all cases determine that the material and heat treatment of the damaged members and of the replacements are identical.

18.703. *Wires and cables.*—

18.7030. Wires or cables shall be replaced if injured or distorted.

18.7031. All control cables  $\frac{3}{32}$ " and above shall be spliced and not soldered, using standard Army and Navy tuck splices of at least 5 full tucks, or a Roebling roll of at least 7 full turns.

18.7032. Neither wires nor cables shall be subjected to heat.

18.7033. The substitution of cable for hard or streamline wires is prohibited.

18.704. *Fabric covering.*—All fabric used for recovering an aircraft structure shall be high grade airplane fabric of at least as good quality as that used originally in the aircraft. The dope and tape used shall be of as good quality as that used on the original aircraft, and the first two coats of dope shall be clear and shall be brushed on. The total number of coats of dope shall not be less than necessary to result in a taut finished job. Both surfaces of fabric covering on wings and control surfaces shall be securely fastened to the ribs by rib-stitching cord or any other method approved by the manufacturer. The spacing of these fasteners shall not exceed that recommended by the manufacturer. When rib-stitching cord is used, the cord shall be linen, or equivalent in strength to that used by the manufacturer. When stitching fabric to the ribs, reinforcing tape shall be used on the top of the fabric and over the ribs on both surfaces. This stitching shall be covered with pinked-edge tape, doped to the fabric.

18.705. *Metal wing ribs and spars.*—Repairs to metal ribs and spars shall preferably be made at the factory of origin or by a repair station which is certificated for this type of work. If this is not feasible, the repair agency shall obtain a recommendation from the original manufacturer and comply with it as to the methods which should be used in making the particular repair.

18.706. *Riveted or bolted truss type metal fuselages.*—The provisions of CAR 18.705 apply to this type of structure.

18.707. *Wood or metal covered (stressed-skin) wings.*—

18.7070. Repairs to damaged stressed-skin or monocoque types of wing structure shall be made at the factory of origin or by a certificated repair station recommended in writing by the manufacturer for this type of work. Such station shall make such repairs in accordance with specific recommendations from the manufacturer.

18.7071. Small holes which in the discretion of a Bureau inspector do not seriously impair the strength of the structure may be repaired by, or the repair may be supervised by, any certificated airplane mechanic, provided the specific recommendations of the manufacturer governing such types of repair are followed. Small holes may be patched by attaching a cover over the hole.

18.7072. In any case, repairs to damaged skin, if very extensive, shall be made by replacing an entire panel from one structural member to the next. Where holes are large, the seam shall be made to lie along a bulkhead or along a structural member.

18.708. *Wood or metal monocoque fuselages.*—The provisions of CAR 18.707 apply to this type of structure.

18.709. *Fittings.*—

18.7090. Damaged fittings shall be replaced by factory parts or by parts made by a repair station certificated for fitting repair work.

18.7091. Worn fittings which were designed without bushings shall not be reamed to oversize but shall be replaced, unless a stress analysis or a test is made to show that the reamed fitting complies with strength requirements. Holes shall not be filled with welding rod and reamed.

18.7092. Torn, kinked or cracked fittings shall be replaced.

18.710. *Wood wing ribs.*—

18.7100. Acceptable methods of repairing a damaged rib are shown in Figures 16 and 17 of ACM 18. Cap strips shall be replaced entirely or repaired at the spars or at a joint in the rib.

18.7101. Damaged web members shall be replaced.

18.7102. Complete ribs shall be made from a manufacturer's approved drawing or from a drawing made by the repair



agency and certified by the manufacturer as correct, except that the original rib may be used as a pattern for making the new rib if it is not too seriously damaged to permit comparison. The drawing, if used, shall be retained by the repair agency for use by the Bureau inspector in making the inspection.

**18.711. Wood wing spars.—**

18.7110. Wood spars may be spliced at any point except at a wing fitting, which shall not overlap any part of the splice.

18.7111. Acceptable methods of splicing the various types of spars are shown in Figures 9 through 13 of ACM 18.

18.7112. No scarf shall be made with a slope steeper than 10 to 1, and all joints shall be made with the highest quality of casein or animal glue.

18.7113. When casein glue is used on soft woods, a pressure of 100 to 150 pounds per square inch shall be applied to the joint during the gluing process. In gluing hard woods a pressure of 200 to 250 pounds per square inch shall be applied.

18.7114. In cases of elongated bolt holes in a spar, a new section of spar shall be spliced in or the spar replaced entirely.

18.7115. Except at a fitting, cracked spars (except box spars) in which the cracks are longitudinal and the wood is not splintered may be repaired by gluing, to both sides of the spar, strips of spruce or plywood of sufficient thickness to develop the longitudinal shear strength of the spar, such strips to extend well beyond the termination of the cracks. When this is done a total thickness of spruce equal to the thickness of the spar web or a total thickness of plywood equal to one-half the spar web thickness shall be used as shown in Figure 15 of ACM 18.

18.7112. *Welded steel tube fuselages.*—Damaged members in steel tube fuselages may be repaired by the methods shown in Figures 1 through 8 of ACM 18, if it is possible to have a stub of the length indicated in the figures.

18.7120. If the member is damaged at the joint so that it is not possible to have such a stub, the member shall be replaced entirely in the case of web members, and in the case of longerons the splice shall be made in an adjacent bay.

18.7121. When it is necessary to remove a member at a joint or cluster, it shall be carefully and completely removed from the cluster without disturbing the surrounding members to which it is attached.

18.7122. A replacement tube shall be at least equal in strength to the original.

18.7123. Where a rosette weld is necessary the hole shall be made in the outside tube only and be of sufficient size to insure fusion with the inner tube.

18.713. *Engine mounts.*—The provisions of CAR 18.712 shall apply to tubular mount members.

**18.714. Landing gears.—**

18.7140. If damaged landing gear struts are made of streamlined tubing they shall not be repaired, but shall be replaced.

18.7141. If damaged landing gear struts are made of round tubing they may be repaired by using splices similar to those shown in Figures 1 through 8 of ACM 18.

18.7142. Damaged axles shall be replaced entirely.

18.7143. The straightening of landing gear struts and the filling of kinks with weld material are prohibited.

18.715. *Wing brace struts.*—Damaged wing brace struts shall not be repaired but shall be replaced entirely.

18.716. *Wing trailing and leading edges and tip strips.*—Repairs to wing trailing and leading edges and tip strips shall be made by properly attached and reinforced splices.

18.717. *Wood compression ribs.*—Wood compression ribs shall not be repaired but shall be replaced entirely.

18.718. *Control surfaces.*—Repair methods on control surfaces will depend upon the type of construction and the extent of damage. Procedure shall be in accordance with such portions of these regulations as are applicable.

18.719. *Hollow steel propellers.*—Damaged hollow steel propeller blades shall not be repaired except by the manu-

facturer. Welding is not permissible on such blades even for very minor repairs except by the manufacturer, due to the special process employed and the heat treatment required. A blade developing a crack of any nature in service shall be returned to the manufacturer for inspection.

18.7190. Minor injuries to the leading and trailing edges only of hollow steel blades may be smoothed by hand stoning provided the injury is not deep.

18.720. *Aluminum alloy propellers.*—Damaged aluminum alloy propeller blades and steel propeller hubs shall be repaired only by the manufacturer or by repair agencies certificated for this type of work. Such repair agencies shall be governed by the following considerations.

18.7200. A damaged metal propeller is one which has been bent, dented or cracked in such a manner as to render it unsafe for flight.

18.7201. Damaged blades with model numbers which are on the manufacturer's list of blades that cannot be repaired shall be rejected.

18.7202. The extent of a bend in the face alignment of blades shall be carefully checked by means of a protractor similar to the one illustrated in Figure 18 of ACM 18. Only bends not exceeding 20 degrees at .15 inch blade thickness to 0 degrees at 1.1 inches blade thickness may be cold straightened. Blades with bends in excess of this amount require heat treatment and shall be returned to the manufacturer or his authorized agent for repair.

18.7203. Blades which are bent in edge alignment shall not be repaired by anyone except the manufacturer or his authorized agent.

18.7204. Damaged blades shall be etched in a 20% caustic soda solution and cleaned in a 20% nitric acid solution, or in a cleaning solution which will produce equivalent results, care being taken not to etch the shank portion. Scratches and suspected cracks shall be given a local etch and examined with a magnifying glass. The shank fillets and the front half of the under surface of the blades from 6 to 10 inches from the tip are the most critical portions. Adjustable pitch blades shall also be etched locally on the clamping portion of the shank at points  $\frac{1}{4}$  inch in from the hub edge in line with the leading and trailing edges, and examined with a magnifying glass for circumferential cracks. *Any crack is cause for rejection.*

18.7205. Nicks and dents on the leading edge and face of blades shall be blended into the blade contour with smooth curves by the use of a riffle file and crocus cloth. After removal of a nick or dent, the surface shall be etched and examined with a magnifying glass, to insure that the nick or dent is entirely removed and that a crack has not started. The surface shall then be polished locally. Blades requiring removal of more material than the following permissible reduction in width and thickness from the drawing dimensions, shall be rejected:

Inner  $\frac{2}{3}$ , 2½%.

Outer  $\frac{1}{3}$ , 5%.

Outer 12", 10%.

Outer 6", May be modified as required.

18.7206. Hubs shall be minutely inspected for cracks by the wet or dry magnetic dust method. Particular attention shall be paid to the inside in the region of the shear shoulders. (Cracks usually start in line with the leading and trailing edges of the blade.) *Any crack is cause for rejection.*

18.7207. Hubs and clamp rings shall be cleaned by stripping off the plating in accordance with the manufacturer's recommended practice. They shall be dimensionally inspected for conformity to the drawing. Particular care shall be taken to check the 90 degree relation between shaft bore and blade socket centerline and track of the blade sockets, as these are the dimensions which are most likely to be affected by accidents. *Any hub which is sprung shall be rejected.*

18.7208. Splines and cone seats shall be carefully inspected for signs of wear. Splines shall be checked with a single



key no-go gauge made to plus .002 of the base drawing dimensions for spline land width. If the gauge enters more than 20% of the spline area, the hub shall be rejected.

18.7209. Hubs and clamp rings shall be cadmium plated after they pass inspection. This plating shall be done in accordance with the manufacturer's recommended practice.

18.7210. Clevis pins, bolts and nuts shall be replaced if they show any indication of wear or distortion.

18.7211. The propeller shall be assembled as recommended by the manufacturer, and checked for track and balance. All blades must track within plus or minus  $\frac{1}{16}$  inch.

18.7212. Horizontal unbalance may be corrected by adding lead not to exceed  $\frac{1}{4}$  ounce to the concentric hole in the light blade or by removing lead not to exceed  $\frac{1}{4}$  ounce from the heavy blade. An eccentric hole not over three-eighths inch ( $\frac{3}{8}$ "') in diameter for any size blade end shall be drilled and filled with lead to procure vertical balance. The outer edge of such hole shall not be closer than  $\frac{1}{4}$ " to the nearest external surface of the blade. Only one such hole per blade will be permitted. The holes may equal the following dimensions, but in no instance shall they be made larger:

Size no. of shank	Maximum concentric hole diameter	Maximum concentric hole depth	Maximum eccentric $\frac{3}{8}$ " hole depth
00	$\frac{7}{16}$	$2\frac{1}{2}$	$2\frac{3}{4}$
0-V2	$\frac{19}{32}$	$3\frac{3}{4}$	3
$\frac{1}{2}$	$\frac{3}{4}$	$3\frac{3}{4}$	$3\frac{1}{2}$
1	$\frac{3}{4}$	4	4
$1\frac{1}{2}$	$\frac{13}{16}$	4	$4\frac{1}{2}$
2	$\frac{7}{8}$	$5\frac{1}{2}$	5
3	$1\frac{1}{2}$	$6\frac{1}{2}$	6

After securing final horizontal and vertical balance, the holes shall be corked to prevent the lead from falling out. If balance cannot be secured within the allowable limits given above, a reinspection is required because this is more than the maximum amount of unbalance that could occur if all parts were within specified tolerances.

18.7213. Vertical unbalance may be corrected when clamping rings are on the centerline by moving the two rings equally off center in the same direction by an amount which shall not exceed  $\frac{1}{4}$  inch. When the clamp rings are in the 45 degree position due to engine or cowling interference, vertical unbalance may be corrected by moving one ring only towards the front centerline for a distance which shall not exceed  $\frac{1}{2}$ ". If this will not secure perfect balance, a reinspection is required. An arrow shall be stamped on the hub shell and on the clamp ring showing the final location of the ring.

#### 18.721. Wooden propellers.—

18.7210. Wooden propellers shall be inspected for such defects as cracks, bruises, scars, warp, oversize holes in the hub, evidence of glue failure and separated laminations, sections broken off and defects in the finish. The tipping shall be inspected for such defects as looseness or slipping, separation of soldered joints, loose screws, loose rivets, breaks, cracks, eroded sections and corrosion.

18.7211. A wooden propeller damaged to the following extent shall be scrapped:

18.72110 (a). A crack or deep cut across the grain of the wood.

18.72111 (b). A comparatively long, wide or deep cut parallel to the grain of the wood.

18.72112 (c). A separated lamination.

18.72113 (d). An excessive number of screws or rivet holes.

18.72114 (e). An oversize hub or bolt hole.

18.72115 (f). An appreciable warp.

18.72116 (g). An appreciable portion of wood missing.

18.7212. Small cracks parallel to the grain of the wood shall be filled with hot glue thoroughly worked into all portions of the cracks, dried and then sanded smooth and flush with the surface of the propeller. This also applies to small cuts.

18.7213. Appreciable dents or scars which have rough surfaces or shapes that will hold a filler and will not induce

failure, shall be filled with a mixture of casein glue and clean, fine sawdust thoroughly worked and packed into the defect, dried and then sanded smooth and flush with the surface of the propeller. In any case, all loose splinters shall be removed.

18.7214. The finish, where necessary, shall be renewed in accordance with the recommendations of the manufacturer.

18.7215. Tipping shall be replaced when it cannot be properly repaired. Cracks in the narrow necks of metal between pairs of lobes of the tipping are to be expected and are not defects. All other cracks are defects that shall be repaired, or eliminated by new tipping.

18.7216. For balancing, wood propellers shall be mounted on a hardened mandrel on a knife edge balancing stand in a room free from air currents. Each blade shall in turn be placed in a vertical position with the blade extending downward. The propeller shall then remain in either a vertical or horizontal position without showing any tendency to rotate in either direction. If the propeller does not balance, balance may be obtained in the following manner.

18.72160. Horizontal unbalance may be corrected by the application of clear varnish or solder to the light blade. The light blade may be coated with a high grade of clear primer allowing for a finishing coat of clear varnish. After allowing each coat to dry 48 hours, the balance shall be checked. Then, as may be necessary, either the required amount of varnish shall be removed by carefully sandpapering or an additional coat applied, allowing for the finishing coat of varnish which shall be a thin coat of high grade clear spar varnish. The balance shall be rechecked and sandpaper or additional varnish applied as may be required to effect final balancing. Only clear finish is permitted.

18.72161. When it is necessary to remove the finish at the cambered side of the tipping for inspection or repairs, balance may be effected by applying putty to the tip of the light blade after all grease, oil and other such substances have been removed and the surface has dried. The solder to be removed or applied shall be of the approximate weight of the putty. If balancing solder is already present on the wide section of tipping on the back of the heavy blade, the required amount shall be removed by careful filing or scraping. If there is no balancing solder, all of the wide section of tipping on the back of the light blade shall be thoroughly cleaned. All of the cleaned tipping shall be thoroughly tinned with ordinary solder and a soldering iron. A perfect bond must be made at all points between the tipping and the solder. To prevent burning of the wood under the tipping, more heat than is necessary to flow the solder shall not be applied. The required amount of solder shall be distributed over the entire tinned area. The balance shall be checked and, as may be necessary, solder may be removed or added until final balance is accomplished. The necessary coats of primer and spar varnish shall be allowed for.

18.72162. Vertical unbalance may be corrected by applying putty to the light side of the wood hub at a point on the circumference approximately 90 degrees from the longitudinal center line of the blades. The putty shall be weighed and a brass plate weighing slightly more than the putty shall be cut out. The thickness of the plate will be from  $\frac{1}{16}$  to  $\frac{1}{8}$  inch depending on the final area, which must be sufficient for the required number of flat head attaching screws. The plate shall be formed to fit the shape of the light side of the wood hub, and drilled and countersunk for the required number of screws. The plate shall then be attached and all of the screws tightened. After the plate is finally attached to the propeller, the screws shall be secured to the plate by soldering the screw heads. The balance shall be checked and all edges of the plate bevelled to reduce its weight until balance is accomplished.

#### 18.722. Engines.—

18.7220. Repairs to, or overhaul of, certificated engines shall not be attempted by any but certificated engine mechanics or by employees of a manufacturer.

18.7221. In making repairs to (or overhauling) a certificated engine the mechanic shall be governed by the



recommendations set forth in the respective instruction books published by the manufacturer, except when such recommendations conflict with Civil Air Regulations.

18.7222. Only structural parts approved by the Secretary shall be used in making replacements in certificated engines, and the repair agency shall furnish the owner an affidavit showing that the parts used are approved. This affidavit shall be pasted in and shall become a part of the engine log-book.

18.7223. Welding shall not be done on any structural part of a certificated engine except in special cases when it is proved conclusively to the Secretary that the repaired part is as airworthy as originally.

18.7224. Crankshafts shall be carefully inspected for alignment. If bent beyond the manufacturer's permissible limits, a crankshaft shall not be repaired, but shall be rejected.

18.723. *Instruments.*—Instruments with which certificated airline aircraft are equipped, and which are damaged to such an extent that extensive repairs are necessary, shall be repaired or replaced by the manufacturer or a certificated repair station.

[F. R. Doc. 37-2821; Filed, September 23, 1937; 10:20 a. m.]

#### DEPARTMENT OF THE INTERIOR.

##### National Bituminous Coal Commission.

[Order No. 46]

#### AN ORDER REQUIRING ALL DISTRICT BOARDS IN MINIMUM PRICE AREAS NUMBER ONE AND NUMBER TWO TO CONVEY IN THE CITY OF WASHINGTON, D. C.

Pursuant to Act of Congress entitled "An Act to regulate interstate commerce in bituminous coal, and for other pur-

poses" (Public, No. 48, 75th Cong., 1st sess.), known as the Bituminous Coal Act of 1937, the National Bituminous Coal Commission hereby orders and directs:

1. That each District Board in Minimum Price Areas Number 1 and Number 2 shall convene in the Hearing Room of the Commission at the Carlton Hotel, Washington, D. C., on the 27th day of September, 1937, at ten o'clock A. M.

2. That all members of such District Boards are ordered and directed to be in attendance at such meetings, and the Secretaries of such District Boards are hereby directed and required to give notice of such meetings in conformity with the by-laws of their respective District Boards.

3. That at the meetings provided for and required by this order, each District Board shall give consideration to and take action on such matters as in the judgment of the Commission are necessary to give full effect to Orders No. 38, No. 39 and No. 43 of the Commission,<sup>1</sup> and shall perform such other duties and give consideration to and take action on such other matters as may be assigned and referred by the Commission to the District Boards in conformity with the provisions of said Act.

The Secretary of the Commission shall forthwith telegraph this order and at the same time mail copies thereof to the Secretaries of all District Boards in Minimum Price Areas Number 1 and Number 2.

By order of the Commission.

Dated this 22nd day of September, 1937.

[SEAL]

F. WITCHER McCULLOUGH,  
Secretary.

[F. R. Doc. 37-2822; Filed, September 23, 1937; 11:21 a. m.]

<sup>1</sup> 2 F. R. 1688, 1691, 2149 (DI).